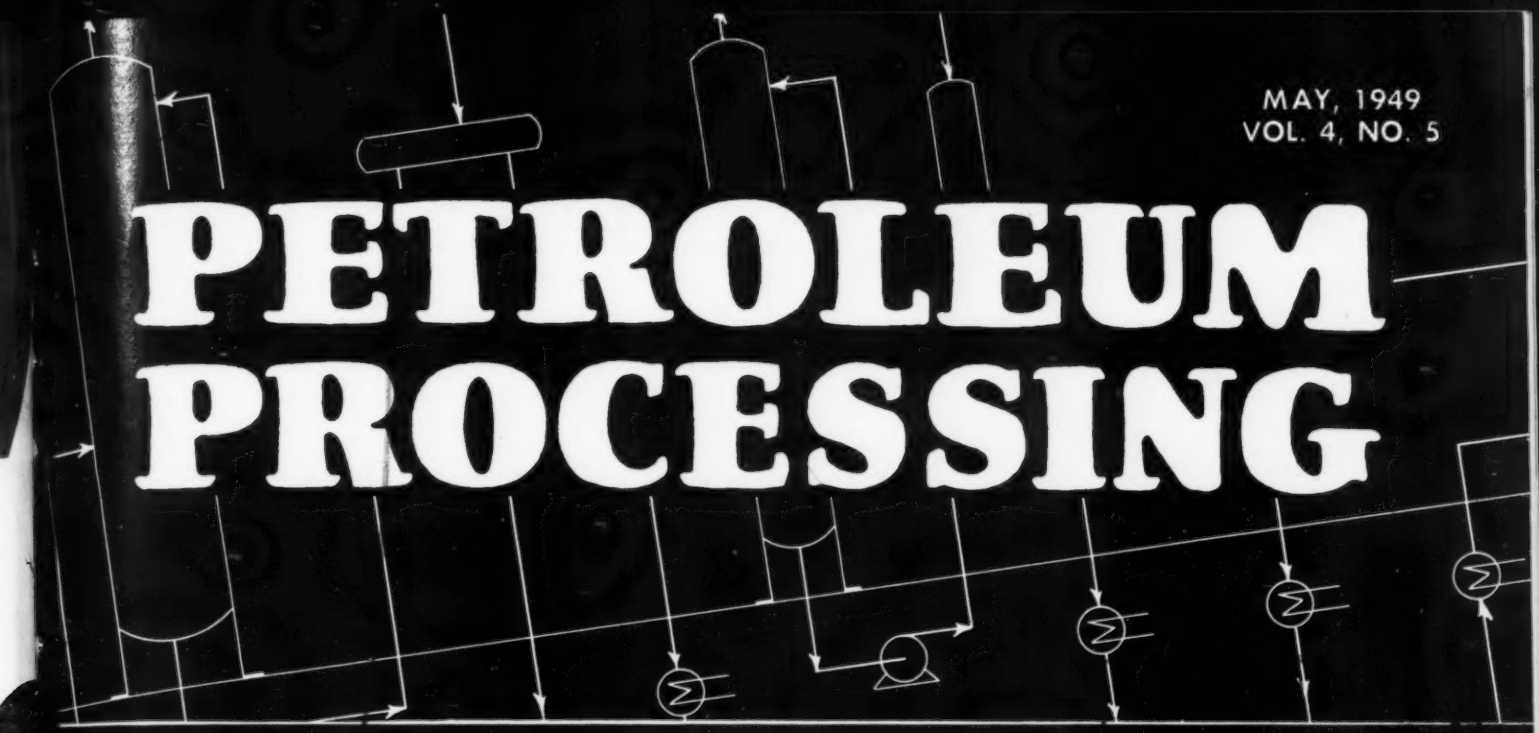
MAY, 1949
VOL. 4, NO. 5

PETROLEUM PROCESSING



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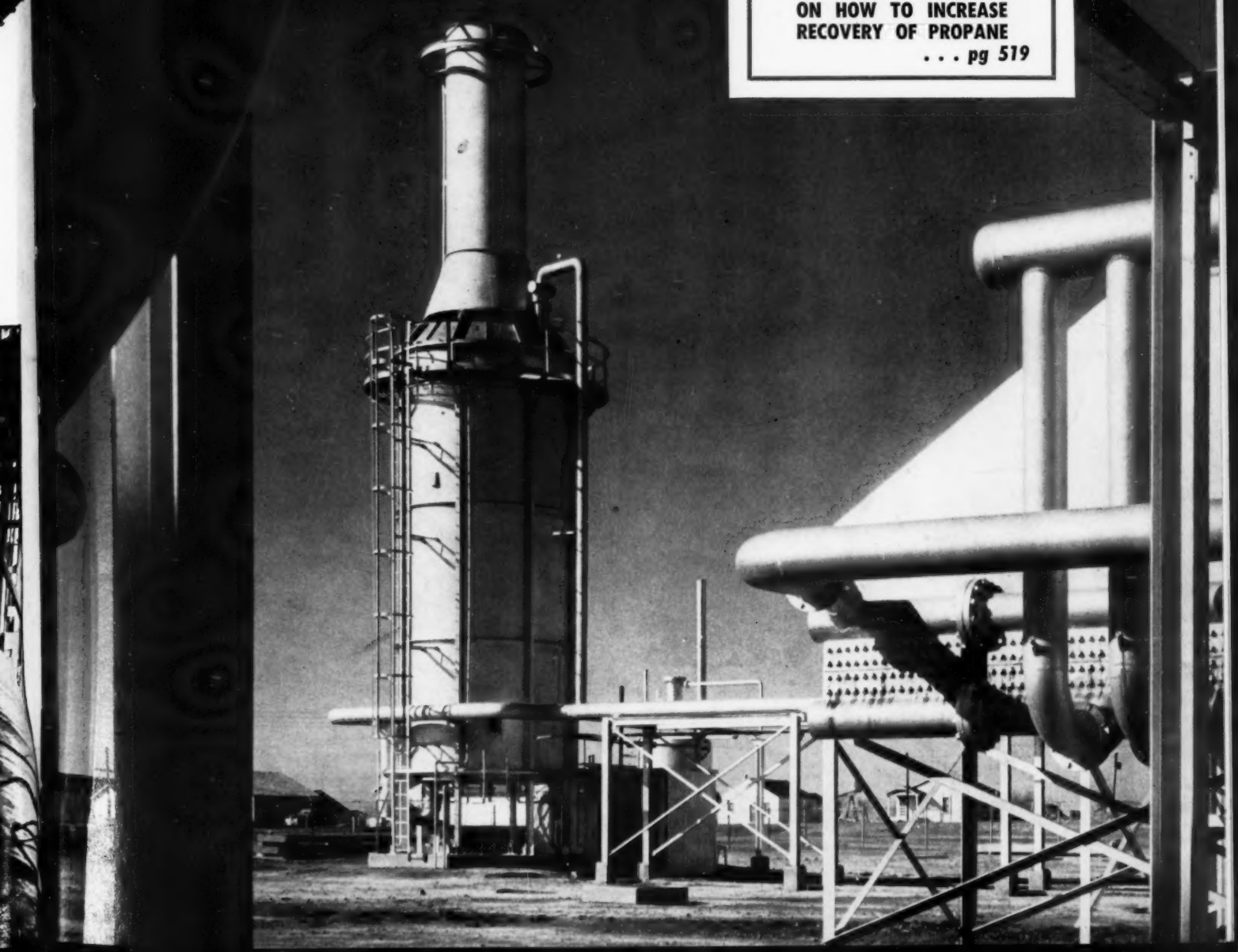
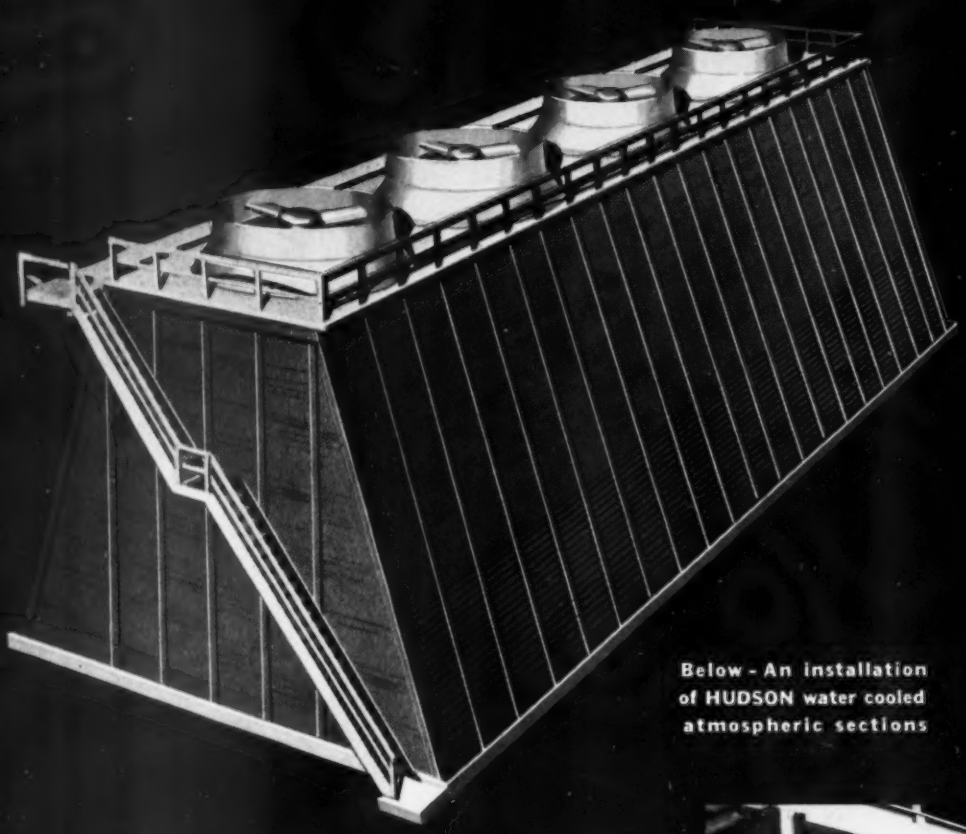


NEW HUDSON Top Performance COOLING TOWERS



Below - An installation of HUDSON water cooled atmospheric sections

IMPROVED AIR FLOW AND AIR-WATER CONTACT

Unique deck design reduces air pressure drop and establishes positive counter current contact between air and water. Tapered sides of the tower eliminate dead space and decrease air turbulence.

LOWER OPERATING COST

Low pumping head and low fan horsepower result in perpetual power savings.

ECONOMY IN FABRICATION AND ERECTION

Prefabricated sections are designed for mass production and easy field assembly.

GREATER STRUCTURAL STRENGTH

Bridge truss type framework with improved timber connectors develops maximum strength in load bearing members.

Undivided Responsibility

Complete integration in selection and design of cooling tower with coolers, results in cooling systems of minimum first cost and minimum operating cost... and the responsibility is undivided.

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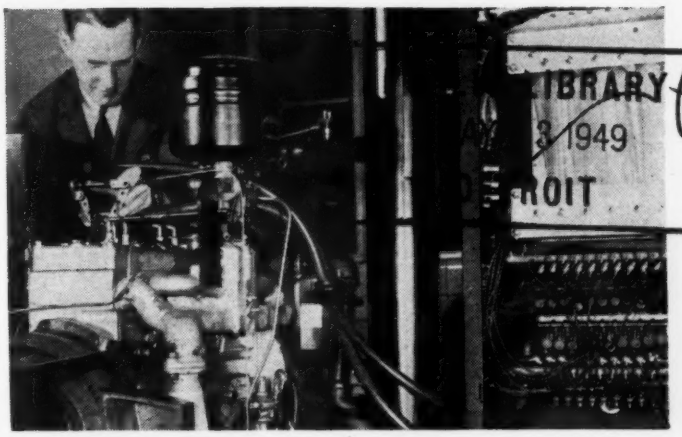
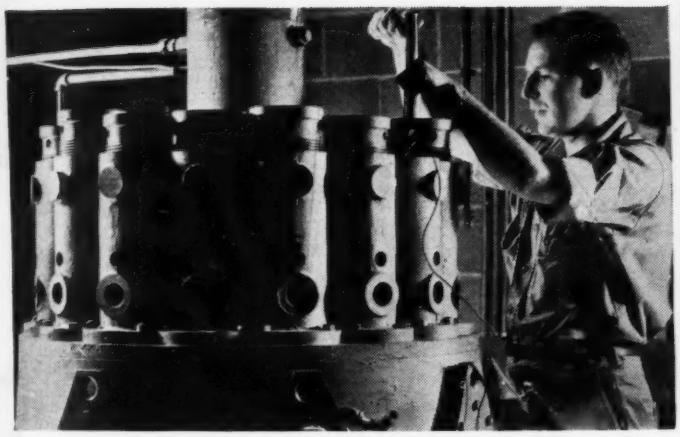
TECHNOLOGY DEPARTMENT

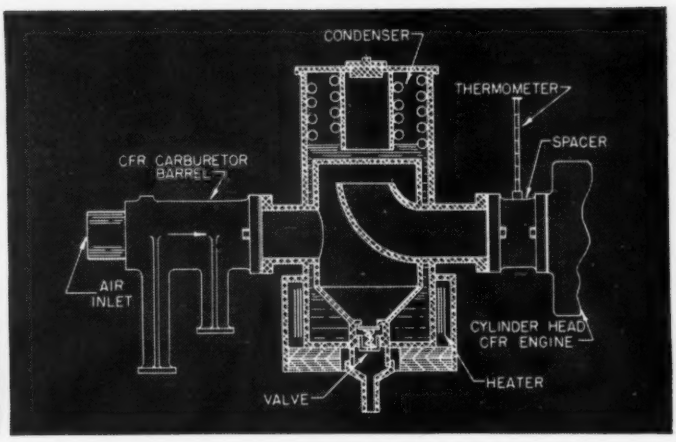
Ethyl-developed research methods useful to refiners



1. Duplicating "road" operation in the laboratory.



2. Testing engine metals under simulated operating conditions.



3. Bled manifold for "knocking" research on single-cylinder engines.

THE DEVELOPMENT of experimental equipment and procedures that will produce reliable data is essential to progress in fuels and engines. For twenty-six years, Ethyl Laboratories have been developing procedures for research on problems relating to engines, fuels, antiknock compounds, and lubricating oils. Many of these have been adopted by other laboratories—some may prove helpful in your research operations.

1. Duplicating "road" operation in the laboratory. The duplication in the laboratory of the performance of engines, petroleum products and antiknock compounds requires a schedule of operation simulating the variations in engine speed and load that are characteristics of road operation. Different types of mechanism—employing pneumatic, electrical and electronic principles—have been devised for reproducing these variations. Illustrated at the right above is one type of automatic control mechanism developed by Ethyl which employs a perforated "piano" roll to operate both dynamometer and engine controls to simulate any desired pattern of road operation.

2. Testing engine metals under simulated operating conditions. The Ethyl Laboratories designed and built for the U. S. Army Air Forces a special furnace (left above). This furnace subjects samples of valve steels to controlled tensile stress under alternate heating and cooling in an atmosphere of combustion products similar to that in engines. This same equipment is used by Ethyl and other laboratories for the testing of alloys intended for fabrication of other engine parts.

3. Multicylinder engine "knocking" research in single-cylinder engines. Some years ago Ethyl engineers measured the variations in the distribution of fuel to the cylinders of engines. It was shown that an irregular pattern of fuel distribution prevailed and that this had a pronounced effect on the knocking tendency of engines and on the relative performance of fuels of different composition. Ethyl engineers have developed a bled manifold for use with single-cylinder knock testing engines that permits, under steady operation, the simulation of transient conditions in respect to fuel distribution existing in multicylinder engines.

• • •

The development of research equipment and procedures is just one part of the overall Ethyl research effort. Ethyl's aim has always been to render a complete antiknock service—to help refiners use "Ethyl" fluid most economically and effectively in the gasolines they produce.

Since 1923—*continuous research to provide better antiknock service*

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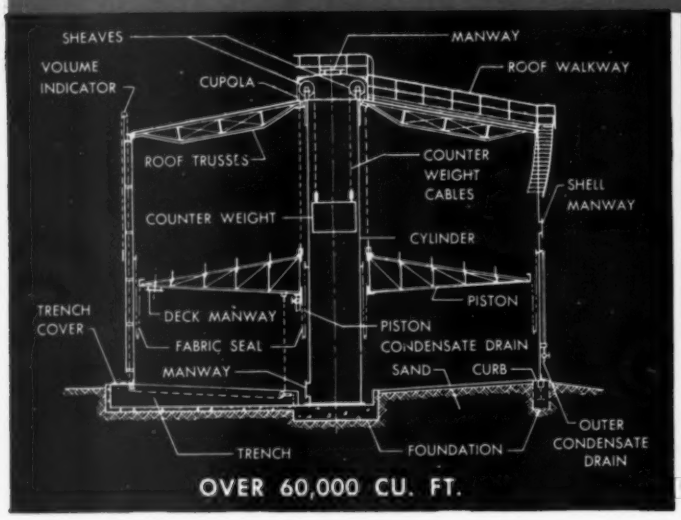
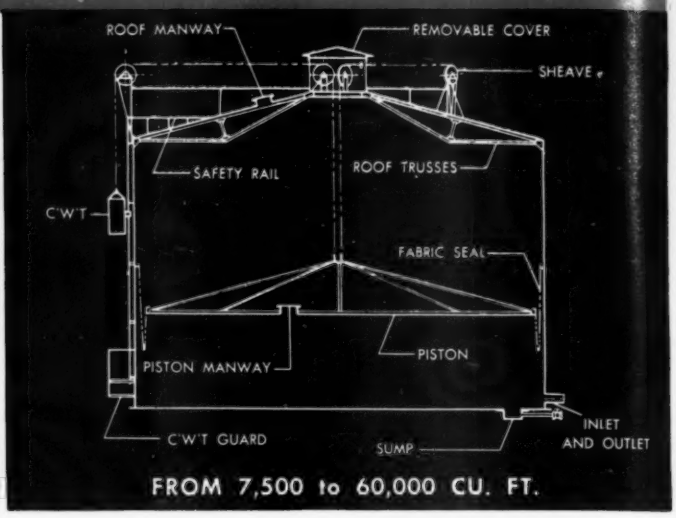


OVER 60,000 CU. FT.



FROM 7,500 to 60,000 CU. FT.

have proved a profitable investment,

because they offer . . .

1. A Gasholder with efficient operation and easy maintenance.

a. Not affected by snow load since all moving parts are under cover.
b. All major moving parts accessible for inspection during operation.
c. A vapor balancer that can be made gas free for repairs in a few hours.
d. A vapor seal that has a life equal to that of the tank.
e. A Gasholder working pressure of ⅛ to ¼ inch of water.

2. A vapor balancer that has a 100% Dry Seal.

a. Eliminates corrosion problems attendant with wet seals.
b. Requires no heating system during freezing weather.
c. Has no evaporation loss through a water or oil seal.
d. Requires no attention, adjustment or lubrication.

3. One vapor balancing mechanism for all tanks.

a. Provides flexibility of operation.
b. Permits repair of any tank in group without affecting operation.
c. Allows vapor balancer to be removed without disturbing storage tank operation.
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e. One structure for protection of all standing and pumping loss.

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PLATT'S OILGRAM PRICES
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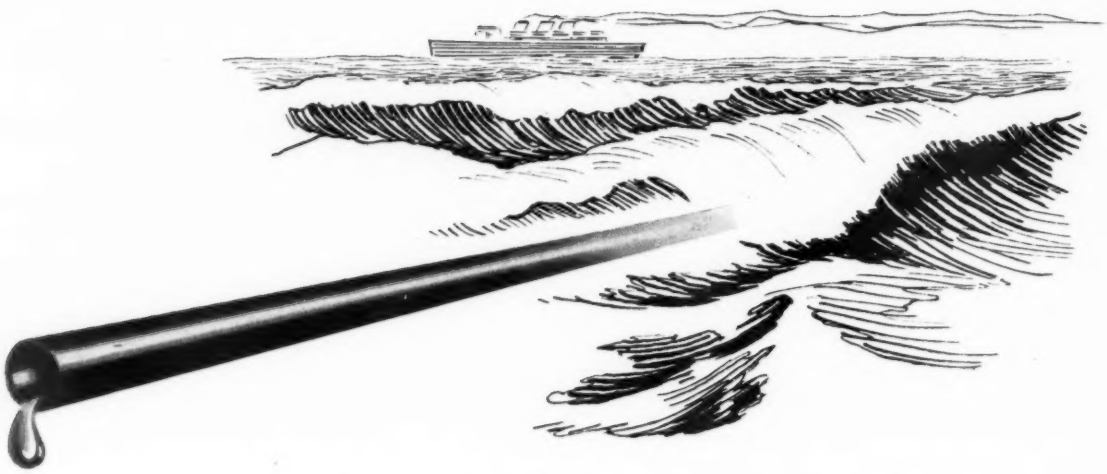

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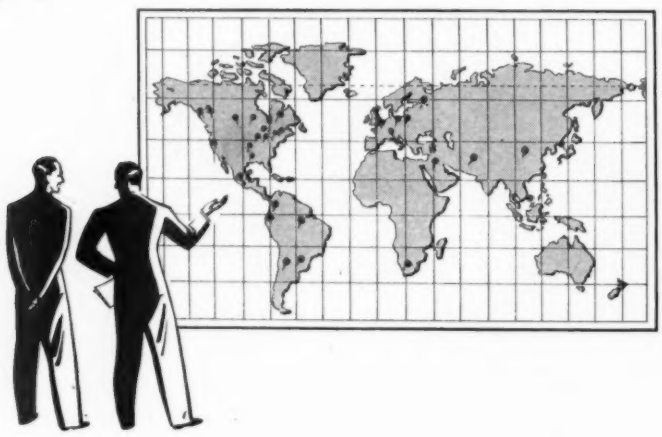

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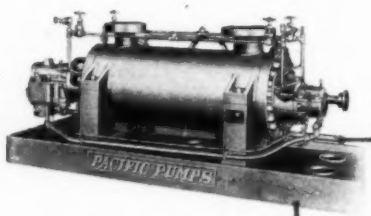
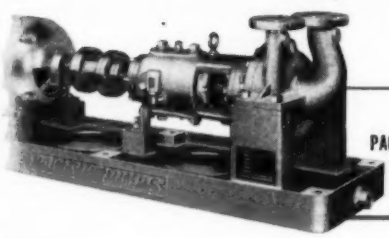
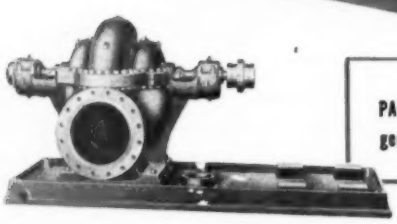


PACIFIC TYPE **I**
hot charge pump



PACIFIC TYPE **SVC**
process pump



PACIFIC TYPE **DC**
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vertical process pump

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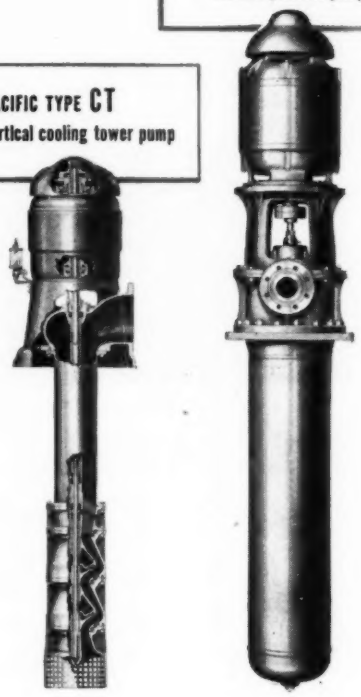
vertical cooling tower pump



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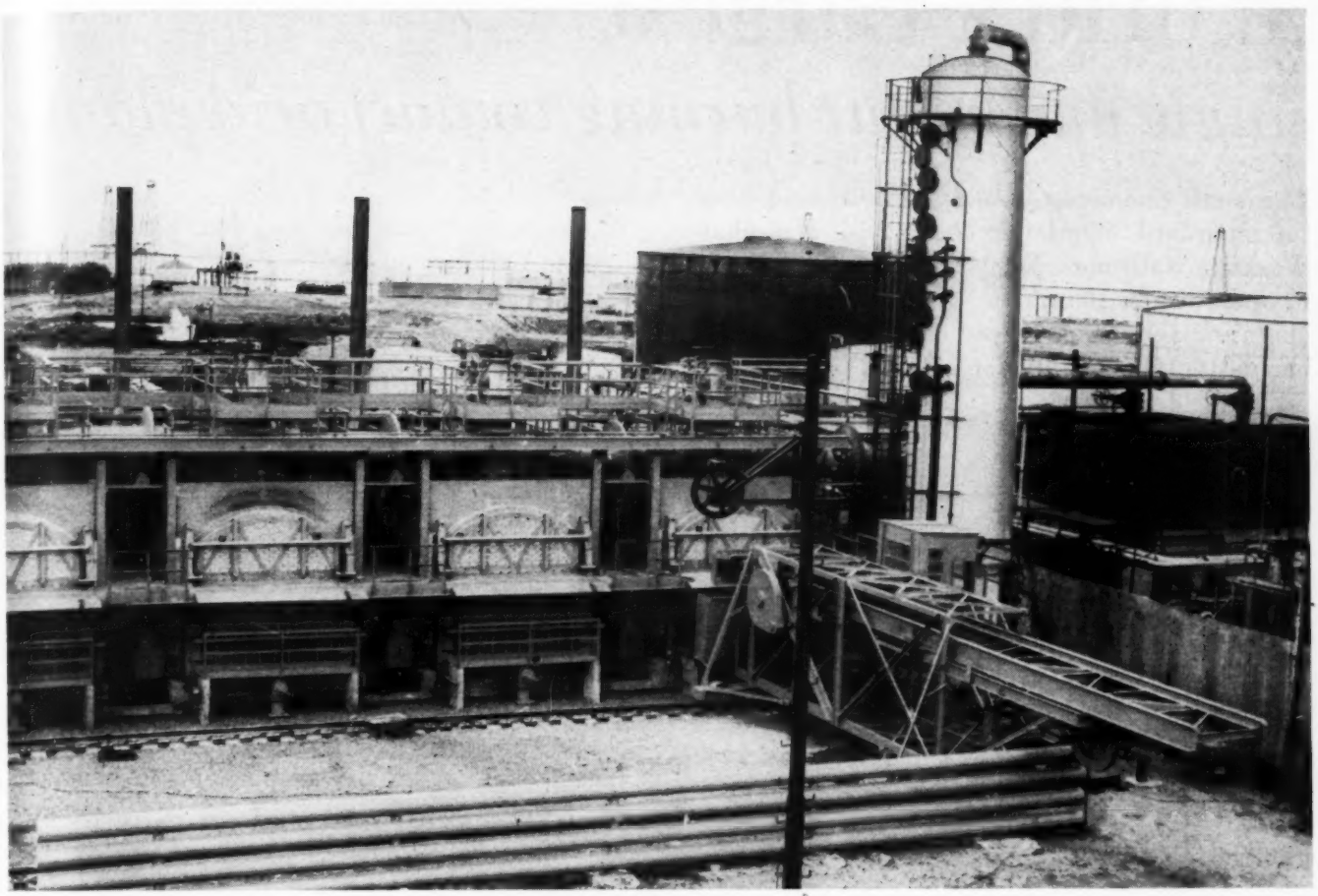

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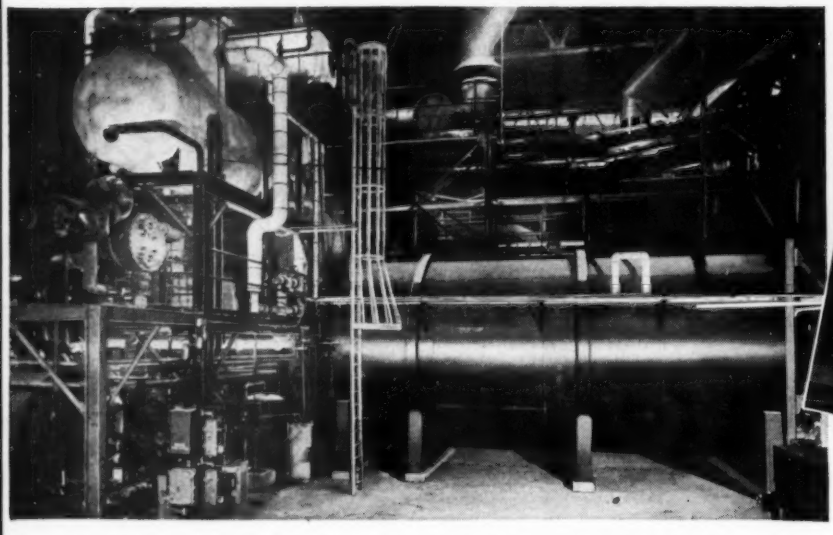
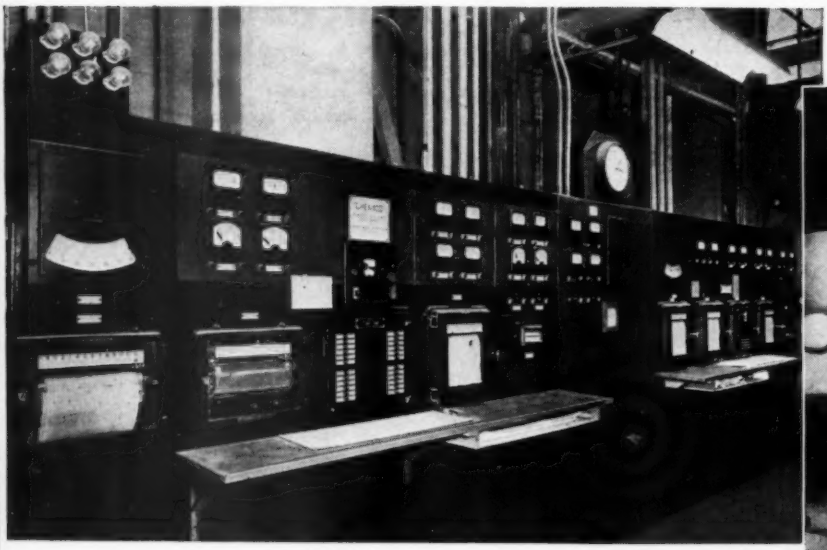
This sixth Chemico Contact Sulfuric Acid Plant for Standard Wholesale Acid and Phosphate Works in Baltimore, Md. was successfully placed in operation in December, 1948 and is regularly operating above guaranteed capacity of 500 tons per day. (100% equivalent H_2SO_4).



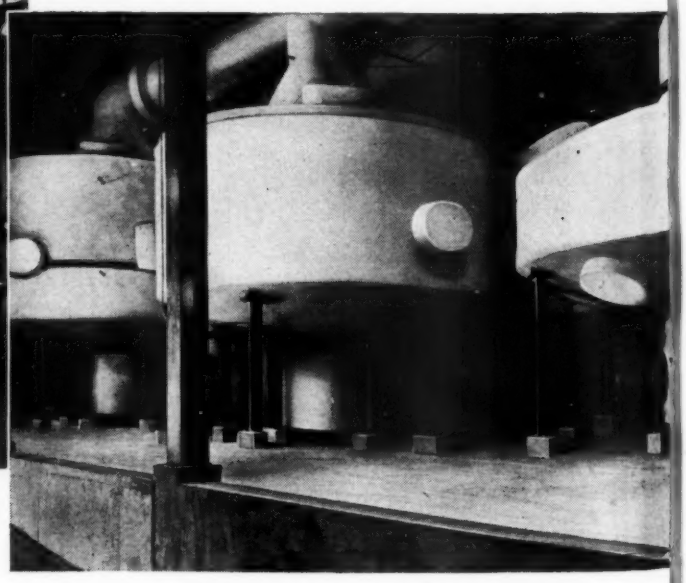
▲ At the right is the Sulfur Furnace with the waste heat boiler, condenser and auxiliary apparatus at the left. This furnace burns over 170 tons of sulfur a day.

▲ Towers for the production of oleum, 98% acid and for the drying of combustion air. These are part of the drying and absorption system.



▲ Here are control panels for two of the six Chemico Contact Acid Plants. The new 500-ton plant panel is on the right.

▼ Shown left to right are the secondary converter, the primary converter and the gas filter.



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Chemico Plants are profitable investments

What's Happening!

Important Current News Summarized for Refiners

REFINERY OPERATIONS

Union Oil Co. of California has undertaken a 3 to 4-year program to reduce its output of residual products, according to President Reese H. Taylor. "Our engineering studies have now reached a point," Reese told stockholders at the company's annual meeting April 12, "which will enable the company to increase its production of gasoline, Diesel oil and other light products by more than 50% by using available crude oil. This would reduce production of heavy fuels by corresponding amount."

Removal of corrosive sulfur compounds from petroleum products is currently costing the oil industry more than $125 million, Dr. Wayne E. Kuhn of The Texas Co., stated during the recent annual meeting of the American Chemical Society. Dr. Kuhn estimated that the cost of new equipment in conversion to handling of sour crudes "may involve an expenditure of more than $7 million for an average sized refinery—one capable of processing 50,000 b/d."

Refiners may be compelled to take liquid hydrocarbons from natural gas along with crude, Brig. Gen. Ernest O. Thompson of the Texas Railroad Commission told the API Refining Division meeting in Houston last month. "If supplies of natural gas liquids stock up," Thompson said, "you may be required to take, in the 10,000 bbls. of oil which you nominate, perhaps 9000 bbls. of crude and say 1000 bbls. of these volatiles."

• • •

MARKETS, PRICES

The season's mixed trends in prices were further accentuated in April with higher prices reported for gasoline and lower for distillates, heavy fuels, propane, and naphthas. Some Southwestern heavy and Penna. grade crudes also were priced lower.

Although domestic crude declines were restricted to lube and heavy fuel bearing oils, many refiners attached greater significance to the 15c/bbl. cuts posted by major Arabian producers in prices for Ras Tanura and Kuwait crudes.

Refinery runs nationwide were down to an average of about 81% of capacity, a reflection of the hesitation and uncertainty accompanying the uptrends in gasoline prices and downtrends in distillates and heavy fuels. In addition many marketers cited the fact that the mixed price trends took place before the nation's stock positions "turned the corner." However, near mid-month gasoline stocks turned downward from a top of around 128 million bbls. and distillates up from a spring low of about 48 million. At the same time, crude stocks above ground were near a peak for this decade, but current production was slightly below estimated requirements.

Principal price developments summarized: Esso Standard, Socony-Vacuum, Atlantic Refining, and other east coast marketers advanced gasoline an average of 0.5c/gal.; heavy fuels ranged 10 to 20c/bbl. lower at the Gulf, East and West coasts, and Mid-continent. Penna. grade crude postings cut back 35c/bbl., and heavy asphaltic crudes from East Texas and Mississippi went down 25c/bbl. Declines reported in prices for lube oils, LPG, and naphthas ranged up to 2c/gal. Some easing in the several-years-old tight supply of avgasoline was indicated.

• • •

LEGISLATION

Compromise solution to "Tidelands" ownership problem has been offered by Rep. Case (R., S. Dak.). His bill would transfer to seaboard states all submerged coastal lands lying within one statute mile seaward of the line of mean low tide. Lands outside that line would be converted into a proposed Federal Waterlands Reserve "for orderly leasing or sale" under direction of Interior Dept. In addition, bill provides that all funds up to $500 million received by the U. S. in any one year from sale of oil or other minerals, or leases, "are to be ear-marked for allotment to the states for current expenditures for public schools."

Recent and current price trends in gasoline caused some talk and one promise of a "probe" in Congress. Freshman Rep. Sidney Yates (D., Ill.), launched a "one-man" campaign against what he claims looks like the "work of a monopoly" in the increase of gasoline prices at the same time the industry "is piling up fantastic profits."

Rep. Rooney (D., N. Y.), speaking in support of a bill hiking appropriations for Justice Dept.'s anti-

Information on these pages is obtained through the nation-wide news coverage services of PLATT'S OILGRAM NEWS

trust division, told House he was "sure" some of the added money recommended would be used for an investigation of "recent half-a-cent-a-gallon increase in gasoline here in the East."

Chairman Maybank (D., S. C.), said his Senate Banking Committee expects "in the near future" to launch a "thorough" investigation into what he termed "uncalled for and unjustified" increases in gasoline prices.

• • •

LEAD PRICES

Plummeting lead prices (five price cuts from March 8 to April 6 reduced the price from a record postwar high of 21.5c per lb. to 15c) have been reflected in lower prices for tetraethyl lead.

Ethyl Corp. made its first price cut March 14, to 59.1c per lb. for motor mix and 64.6c per lb. for aviation mix. Then on April 7 the company again reduced prices, effective April 5, to 57.7c per lb. for motor mix and 63.2c per lb. for aviation mix.

DuPont followed suit in both cases, and on April 8 announced price reductions, also effective April 5, to 34.474c per lb. for motor mix and 38.811c per lb. for aviation mix.

These latest prices for both companies are equivalent to about .21c per cc. of TEL content for motor mix, and .23c per cc. of TEL content for aviation mix.

• • •

EXPANSION

Salt Lake Refining Co. at Salt Lake City, Utah, is planning a $10 million expansion program to increase Diesel fuel and high octane gasoline capacity. New cracking facilities are expected to be completed by the end of 1950, and will provide capacity to process feed stocks produced from 24,000 b/d of crude. Present plant capacity is 15,000 b/d.

Hydrogen sulfide-containing waste gases from The Texas Co.'s Eagle Point refinery in Westville, N. J., will be used in a new 40 ton per day sulfur recovery plant to be built there. The plant will be erected within the refinery limits, but will be owned and operated by Freeport Sulfur Co. Primary purpose is to minimize atmospheric pollution, while at the same time producing a commercial product. The Girdler Corp. of Louisville, Ky., is contractor.

Skelly Oil Co. is enlarging and modernizing its Eldorado, Kans., refinery from 25,000 to 35,000 b/d capacity. Cost is estimated at $8 to $10 million. New units include catalytic cracking and new crude distillation. Completion is scheduled for 1950.

New fuel-testing facilities were recently put into operation by Pan American Refining Corp. with the dedication April 28 of its modern Automotive Research Laboratory at Curtis Bay (Baltimore), Md. Outstanding feature of the new lab is a chassis dynamometer, said to be the largest in the world, for testing motor fuel performance under road-load conditions.

• • •

Cities Service Oil Co. has awarded contracts for construction of a $4 million compounding plant at Cicero, Ill., to Sumner S. Sollitt & Co. of Chicago. Designed to compound and blend over 23 million gals. of lube oils yearly, the new plant will be located on a 42-acre tract abutting the Illinois Ship Canal. Blending stocks will be obtained from the new Cit-Con plant at Lake Charles, La., by barge. Completion is planned for early 1950.

United Gas Pipe Line Co. has retained Delta Engrg. Corp. to build a 10,000 Mcf. natural gasoline plant near Karnes City, Texas, for completion January, 1950. Estimated daily recoveries are 5700 gal. propane, 3700 gal. butane, 16,500 gal. natural gasoline, and 5000 gal. stabilized condensate.

• • •

TRANSITION

New York Lubricating Oil Co.'s facilities at Perth Amboy, N. J., have been purchased by California Refining Co., eastern subsidiary of California Standard.

The former Danciger Oil & Refining Co. plant at Longview, Texas, purchased last September by W. C. Berry of Tulsa, has now been resold to the Poggio interests of Milan, Italy, and other associated individuals there.

American Mineral Spirits Co. has shut down and placed its Corpus Christi plant on indefinite standby, as well as closing offices there "because of economic conditions in the industry." Rated at 13,000 b/d, the plant averaged 8000 b/d throughput for past year: it has no cracking facilities.

• • •

PETROCHEMICALS

Cresylic acid is now being made from petroleum raw materials, by the Merichem Co. in its new $500,000 plant at Houston, which went on stream April 15. Three boiling ranges of the product are available in tank car and drum lots—183-205° C., 205-230° C., and 230-245° C.

Lion Oil Co.'s chemical division last year accounted for about 22% of the company's gross revenue of over $66 million, according to Lion's annual report. Lion's principal petrochemical activity is the manufacture of ammonia and fertilizers from natural gas in the former Ozark Ordnance Works near El Dorado, Ark.

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Cleaned! 757 cu. ft. of scale removed in 30 hours

Complex construction of Open Box Condenser is no problem for Dowell Chemical Scale Removal Service

An open box condenser at a Midwestern oil refinery was heavily coated with scale. *Within 30 hours*, Dowell Service removed an estimated *757 cu. ft.* of scale and the condenser was back in service!

Fast, effective cleaning of industrial heat exchange equipment is made possible by Dowell Service. Carefully selected solvents penetrate wherever water flows and are designed to remove troublesome scale from all surfaces contacted. Costly dismantling or modification is not required—the necessary solvents are pumped into the equipment using existing connections. When the scale is dissolved or disintegrated, the spent solution is pumped out, the unit flushed and put back in service. Expensive down time is held to a minimum.

Whenever you have a scale removing problem, look to Dowell. Experienced Dowell engineers do the job, bringing the equipment necessary to insure proper control at every stage of the operation.

Call the nearest Dowell office today for details about the fast, effective, and economical Chemical Scale Removal Service for boilers, heat exchange equipment, condensers, and water lines. Free estimates gladly given.

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New York 20, Boston 16, Philadelphia 2, Baltimore 18, Wilmington 99, Richmond 19, Atlanta, Buffalo 2, Cleveland 13, Pittsburgh 19, Detroit 2, Chicago 2, St. Louis 8, Indianapolis, Louisville, Kansas City 8, Wichita 2, Oklahoma City 2, Houston 2, New Orleans 12, Ft. Worth 2, Shreveport 23, Anniston, Alabama, Mt. Pleasant, Mich., Hamilton, Ohio, Charleston 27, W. Va., Salem, Illinois, Borger, Texas, Midland, Texas, Wichita Falls, Texas, Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

N.B. While it is axiomatic that return on investment—the *ultimate earning power* of a refinery unit when actually on stream—is the only true evaluation of competitive engineering recommendations, initial plant costs remain a major factor in refiners' decisions on plant installations. M. W. Kellogg takes specific steps to *minimize initial plant costs* consistent with the achievement of *highest ultimate earning power.*

HOW KELLOGG CUT LINING COSTS BY OVER 50%

For many years, accepted practice has been to line regenerators with refractory tile and block insulation costing from $10 to $12 a square foot installed.

Kellogg design engineers considered this an unreasonably high expense and decided to pioneer a new type of vessel lining. Kellogg's refractory and insulating specialists consequently experimented with new materials and methods that would reduce this cost yet provide the same or better performance.

A solution was found in Kelcrete*, a new refractory material that can be "gunnited," or sprayed, on a wire mesh supported on the inner surface of a vessel. Not only is Kelcrete less expensive than tiling but it is also less costly to apply. *Total cost is about $4 a square foot installed*—more than 50% saving over old methods.

Furthermore, it exhibits excellent stability, although continuously exposed to temperatures of 1100° F... is longer lasting than other materials... and is easier to repair. Gunnited Kelcrete is now a standard material for this and similar applications in units engineered and constructed by Kellogg.

This story of Kelcrete underlines just *one* of the ever present opportunities for paring the initial cost of new refinery units—opportunities available only to the resourceful engineer-contractor who has a complete organization... one that *supplies within itself* all the requisites for obtaining unbiased solutions to initial-cost-vs.-earning-power problems.

Such completeness of organization and the close cooperation between the various specialists at M. W. Kellogg are the soundest approach to LOW INITIAL PLANT COSTS.

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. . . IN PETROLEUM TECHNOLOGY

Brief reviews of currently reported technological and economic developments, in the light of their potential bearing on petroleum refining

New Notation System Confronts Chemists

PETROLEUM CHEMISTRY is a complex field, replete with the necessity for considering materials ranging in structural "simplicity" from elemental carbon and hydrogen to asphaltic and resinous substances of vast molecular weights and multimolecular structures. As a result, the nonchemical petroleum worker shudders when he, by chance, looks at a book or article on some organic chemistry phase of the field, and even the chemists and chemical engineers must often "sharpen up" their knowledge of chemical nomenclature if they would understand the erudite writings of their advanced brethren or prepare technical papers themselves in the best of form.

Moreover, the complexity of organic chemistry is such that even the expert must pause to consider what is meant when he finds a reference to such compounds as 1,1-dimethyl-3-(3)2-methopropen (3)-yl) cyclohexen-4. It is for this reason that a new system of notation for organic compounds—Dysonian notation—is capturing considerable attention, especially among those who must use the chemical literature and its complex, confusing, and often inadequate subject and formula indexes.

For ring compounds, for example, a fully saturated ring under this new system becomes "A," an aromatic ring becomes "B," structures intermediate in saturation between A and B employ "E" to indicate a double bond, etc. Even elemental details cannot be given here, but it must suffice to say that the Dysonian system has remarkable values for chemical shorthand (the compound B6,3,1 (2)7,19,21,1-7.ZQ,31.ZN,9, 10. H, 1, 7, 31, horrifying as it looks even in the Dysonian system, would stun all but the best versed chemists who saw it stated in "normal" terminology), and compounds so ciphered lend themselves excellently to easy index arrangement.

To date, the Dysonian system—first introduced in this country at an American Chemical Society meeting in 1947 by its English originator, Dr. G. M. Dyson—has not penetrated much further than those circles whose business it is to work with the chemical literature, but those who are working actively with it and on its further development feel almost certain that it will eventually be adopted in place of "common" notation.

Chemists, like all classes of humans, will naturally be reluctant to stop using a system mastered by hard training, especially when some additional training will be required to employ a new system, no matter how good it is and how easy it is to use, once learned, but notice is hereby served that the Dysonian system of notation is on the way in. In the petroleum field particularly, chemists will do well to adopt it early, for it holds special advantages for them.

World Energy is Linked Closely with World Peace

WHILE PETROLEUM INDUSTRY efforts have put the supply and demand of oil and its products into more than close balance and have substantially eliminated any real need for hasty action on synthesizing liquid fuels on the grounds of near-future shortages and military insufficiency of supplies, the subject of domestic and world energy supplies continues to be of much more than academic interest. Some of the facts of this situation were well stated last year by R. T. Haslam, vice president of the Standard Oil Company (N. J.), in a speech at the Massachusetts Institute of Technology:

"1. There is ample energy in the world for our logistical task.

"2. The technical problems of converting solid fuels such as coal to liquid fuels have been solved.

"3. Fuel resources are fairly well scattered throughout the world.

"4. The problem is not one of resources so much as it is the development and use of these resources, particularly outside the United States."

In his speech, Haslam dwelt extensively on all phases of his part of a symposium on "Logistics of Peace." The fundamental elements of a peaceful climate, according to Haslam, are "(1) a world in which the people rule, (2) a world in which the maximum freedom and opportunity are given to the people, (3) a world in which production is expanding, and (4) a world in which we keep the virtues of national feeling but begin to outgrow some of the vices of nationalism." If the world develops its fuel resources, they should be sufficient for 1000-3000 years, even without recourse to nonfuel sources of energy.

In a nutshell, Haslam believes that "in a world of peace without economic barriers, our problems are not severe." Whether or not this peaceful world will ever come into being is indeed a question—much more so than in 1946, for example. It is therefore highly important that we continue to prepare for war while we work for peace, but occasional papers such as this serve to remind us that our technical problems would be much simpler if "man's inhumanity to man" could be eliminated.

Underground Gasification Studied by Chemical Company

THE SYNTHESIS OF "PETROLEUM CHEMICALS" is today requiring larger and larger quantities of C_2-C_4 hydrocarbons, and these "popular" materials are now far from as readily available at a low price as they were in the days when they were utilized almost wholly as refinery fuels. It is therefore highly interesting but not greatly surprising to note that it is reported(1) that the Carbide and Carbon Chemicals Corp. is actively interested in underground gasification of coal as a possible (eventual) inexpensive source of hydrogen, which in turn would reportedly be used for the hydrogenation of coal "clear down to the C_2-C_4 range" in order to augment Carbide's supplies of these substances from refinery gases, natural gas, and coke oven gases.

According to this source, "Carbide has purchased rights to the coal under about 30,000 acres in central West Virginia" and is "experimenting with underground gasification at a spot about 15 miles up the river from its South Charleston, W. Va., plant . . . And Carbide is also working on coal hydrogenation."

Such research by a private company closely allied with the petroleum industry is highly significant. Carbide, apparently, does not care to await the results of the second experiment in underground coal gasification now being jointly conducted near Gorgas, Alabama, by the U. S. Bureau of Mines and the Alabama Power Co. This would make it appear that Carbide does not consider

(1) Anon., *Chemical Engineering* 56, No. 3, 76 (1949).

underground coal gasification as such a "long-term bet." Alternately, it may be that this company is working only on phases not under study elsewhere, although even this does not remove the implication of near-future use since such experimentation is far from inexpensive and would probably not be conducted by a private company unless the information sought was thought to be of near-future value.

Another intriguing aspect is the report that Carbide is working on the development of methods of hydrogenating coal clear past the gasoline range, a process which, to quote *Chemical Engineering*(1), "will gobble up hydrogen." Coal hydrogenation is an expensive process, even for the production of heavy and medium fuel oils, and it would appear on the surface that it would require much more drastic treatment to obtain high yields of C_2-C_4 gases. An economic compromise might, of course, be effected, since gasoline and other coproducts would be readily marketable. An inexpensive supply of hydrogen, obviously, is one keystone of the desired process, hence Carbide's research on underground coal gasification. The "producer gas" so prepared would be further reacted with steam to increase its hydrogen content.

It seems unlikely that much real information on this work will be made public soon; Carbide and Carbon has never been over-free with technical information which might affect the economic status of its products, and will probably see little reason for describing internal processes which leave no marks on its products. About all that the industry can do is to watch for patent developments—that is, unless others are inspired to conduct similar experiments for themselves.

Electrodeposition Applied to Plastics

THE PLASTICS INDUSTRY is one of great interest to present and potential manufacturers of chemicals from petroleum. Most of the important new plastics developed in the last 15 years are derived from petrochemical intermediates, and this trend toward the use of large quantities of petrochemicals for the production of plastics shows no signs of change.

A new technique in the plastics field which indicates increasing the utility of, and demand for, these materials is the electrodeposition of plastics. It is currently attracting much attention.

Rubber films have long been electrodeposited from aqueous latex, but plastic latices were not commercially available until 1943. Many commercial plastics are now produced by emulsion polymerization methods, however, and "with slight changes in formulation are suitable for electrolysis in the original polymerization emulsion."(2) Potentially, therefore, these resin latices should be less expensive than molding powders, which must be processed from them by drying and powdering. So far, however, the special handling necessitated by the additional cost of shipping 45% of water with the resins has more than eliminated the savings in processing costs, and latex emulsions at present cost approximately 50 cents per pound of solids, slightly more than the cost of molding powders.

"Any plastic material which will form a stable aqueous emulsion containing about 50% solids" can be electrodeposited. The colloidal particles in such emulsions (which may also contain plasticizers, etc.), being negatively charged because of the use of anionic stabilizers of the alkyl sulfate and alkyl aryl sulfonate types migrate to the anode in the plating tank (electrolytic cell), which is divided by a thin barrier of porcelain to prevent migration of hydrogen evolved at the cathode. "The latex is placed in the anode compartment of the plating tank; the cathode chamber is filled with a 5% sodium chloride solution."

Anode selection is an important factor, since the dissolving metal ions from the anodes have various effects on emulsifying agents and may contaminate the plastic films. Nickel has been found to be generally satisfactory. However, porous barriers or molds containing mercury, which form insoluble anode products that do not penetrate the barrier, may be employed to yield metal-free films. Such forms, however, reduce rate of deposition by 85%. Copper is the common cathode material, since it does not dissolve in the electrolyte.

The films produced do not attain maximum strength without baking for 0.5-1 hour at 80-150° C., exact conditions depending on the use or nonuse of plasticizers in the latex. "Most plastic sheets strip easily from the electrodes or porous barriers;" by proper selection of materials, however, permanent plastic coatings can be placed on metal objects by this method.

Power requirements are extremely small; "deposition efficiency is about 2,500 grams per faraday at rates as high as 100 kg. per kw.-hr." Under normal rates of 10-12 kg. per kw.-hr., a 0.125-inch film can be deposited in about 15 minutes on metal electrodes.

Plating tanks are vastly less expensive even than low pressure molding equipment, so electrodeposition has great potentialities where applicable. Its increased use seems certain.

(2) M. L. K., "IEC Reports—Plated Plastics," *Industrial and Engineering Chemistry* 41, No. 2, 14A, 16A (1949).

Congressional Documents Often of Significance

IN A REPUBLIC, the machinery of government often provides a truly fascinating spectacle. The system of checks and balances between administrative, legislative, and judicial agencies has proved amazingly sound, reducing as it does the chance for hasty, unreasoning action. Not that every act is thereby perfect; human nature is too "human" for that, and politics frequently dictate strange performances. However, the system *is* good enough to allow those interested both in government and in its relation to a given subject or industry to sit back occasionally to enjoy some of the humor unconsciously involved and to ponder on the significance of certain happenings.

Among the somewhat humorous measures recently introduced in Congress are two bills, one of which (H. R. 1429) provides for the authorization of an experiment station near Marietta, Ohio, "to conduct researches and investigations on the production, refining, transportation, and use of petroleum and natural gas," while the other (H. R. 194) in almost identical terms calls for an experiment station "in the Hocking Valley coal region" of Ohio "to conduct researches and investigations on the production, refining, transportation, and use of petroleum and natural gas *from coal oil and shale.*"

The humor involved, of course, is of the unconscious type; both congressmen undoubtedly seriously thought they would materially contribute to the well-being of their state if Congress were to authorize the Bureau of Mines to expend $1,000,000 on the construction of one or both stations and then to spend $500,000 or $100,000 annually, as the case may be, to operate these laboratories. What they neglected to note, however, was that, if this were done, similar claims for experiment stations could be advanced by almost every region for almost every raw material of national importance. To obviate this necessity is one of the reasons for the several (but only several) main experiment stations of the Bureau of Mines, each built with a view to central location.

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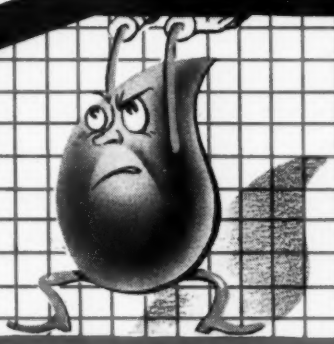

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TYPICAL ANALYSIS OF SANTODEX

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% Ash	Nil
Color (NPA)	2
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Fig. 2—Note blending of ear portion of welding fitting to run pipe. Extension of weld metal below inside scarfed portion of pipe insures all sections of joint greater than pipe wall thickness.

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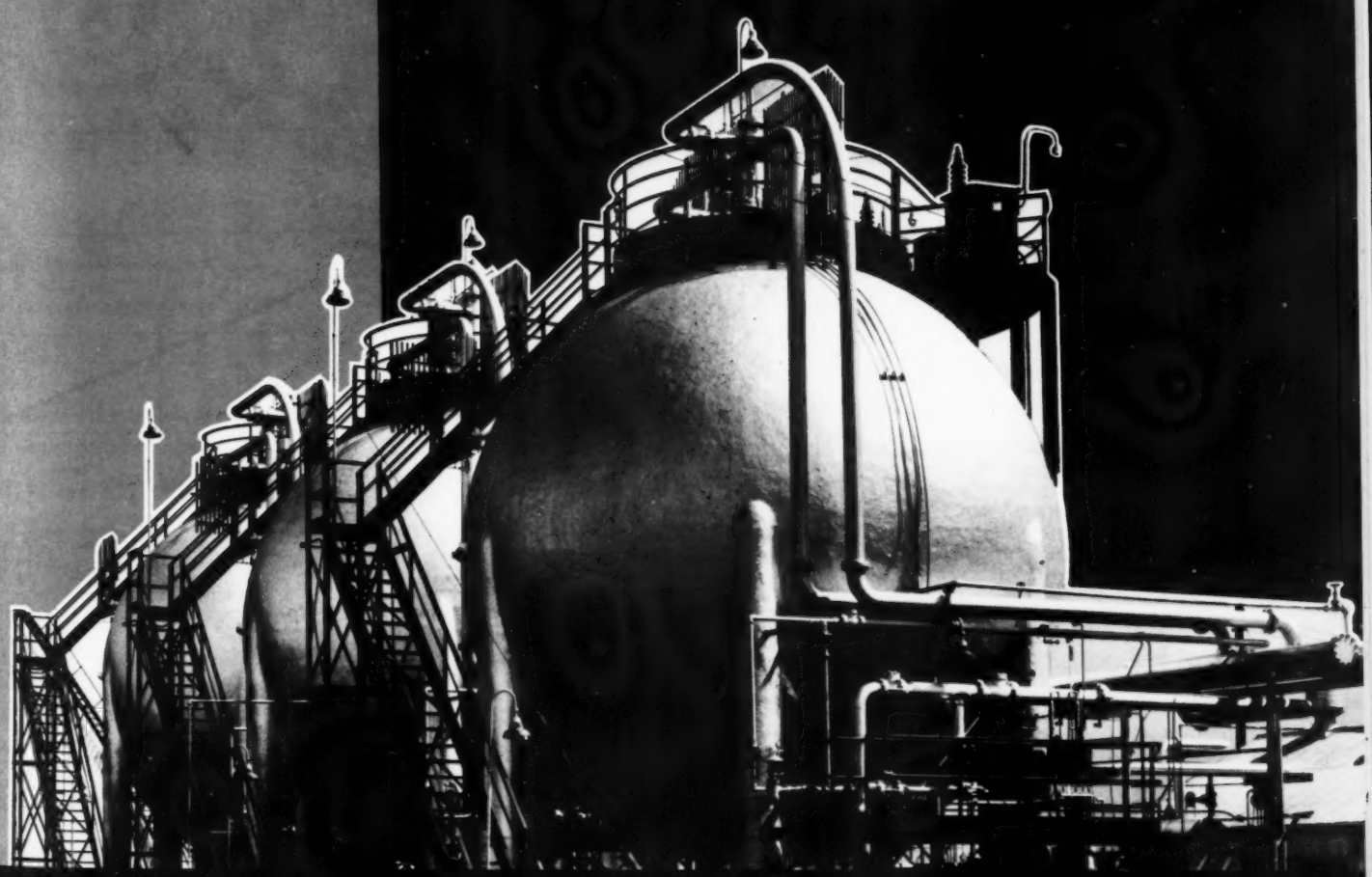
SALT *in the crude charge*

how much is harmful?



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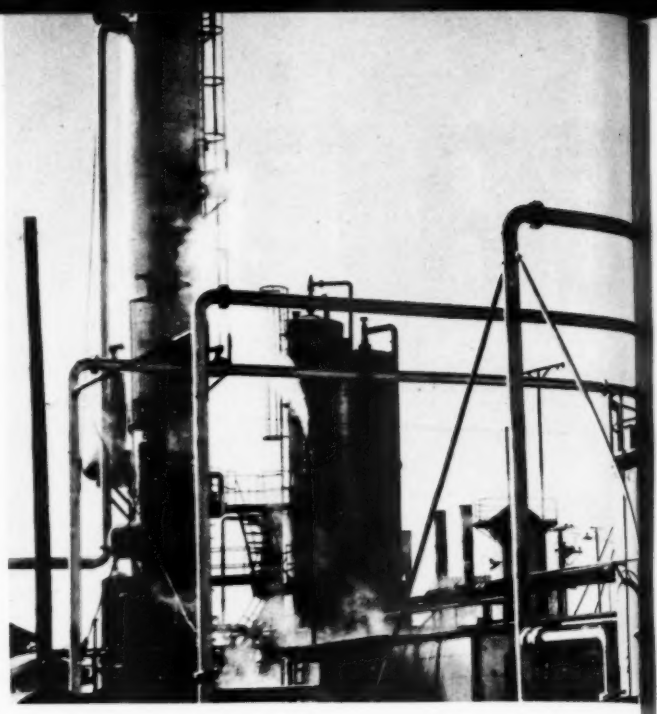
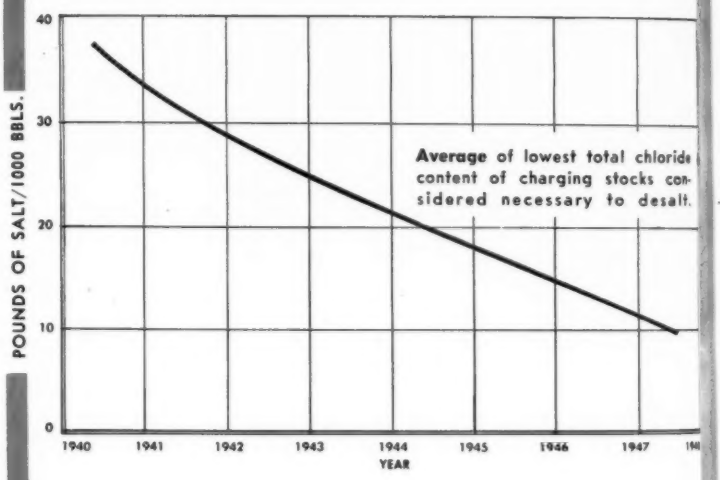
THE AMOUNT OF SALT CARRIED INTO THE REFINERY EQUIPMENT in the charging crude often reaches surprising proportions. For example: 10,000 barrels of a crude containing only .15% water will often carry close to a half a ton of salts. The potential injury to the refining equipment from the continuous introduction of salts in such quantities can easily be visualized. Some desalters operate on crudes that carry from 500 to 800 pounds of salt per thousand barrels; in other cases, refiners find it profitable to desalt stocks containing even less than 10 pounds per thousand barrels. It is difficult to set any lower limit of acceptable salt tolerance since this depends upon the nature of the salts, the character of the crude, the type of refining equipment and the operating conditions. Furthermore, refiners have found that continued experience with desalting repeatedly reveals benefits which were not expected when the desalters were installed. As a result, they now desalt crude stocks having salt contents formerly considered to be below the economic limit.



THIS TREND IN THE INDUSTRY TO DESALT STOCKS OF PROGRESSIVELY LOWER SALT CONTENT IS GRAPHICALLY SHOWN IN THE ACCOMPANYING FIGURE. The curve is plotted from the electrical desalting records of one refining company and is typical of the trend in the industry as a whole. It reflects the increasing conviction that even oils formerly considered to have negligible salt contents will, with desalting, show beneficial effects to such an extent that the processing is easily justified.



THE DETERMINATION OF SALT is not difficult and is routine with most refiners. For helpful information on salt determinations, request a copy of the PETRECO MANUAL on SALTS IN PETROLEUM (yours for the asking at any Petreco office or from any Petreco engineer). Or, if you prefer, samples of your crude can be sent to the Petreco laboratories and the results of the analysis will be reported to you.

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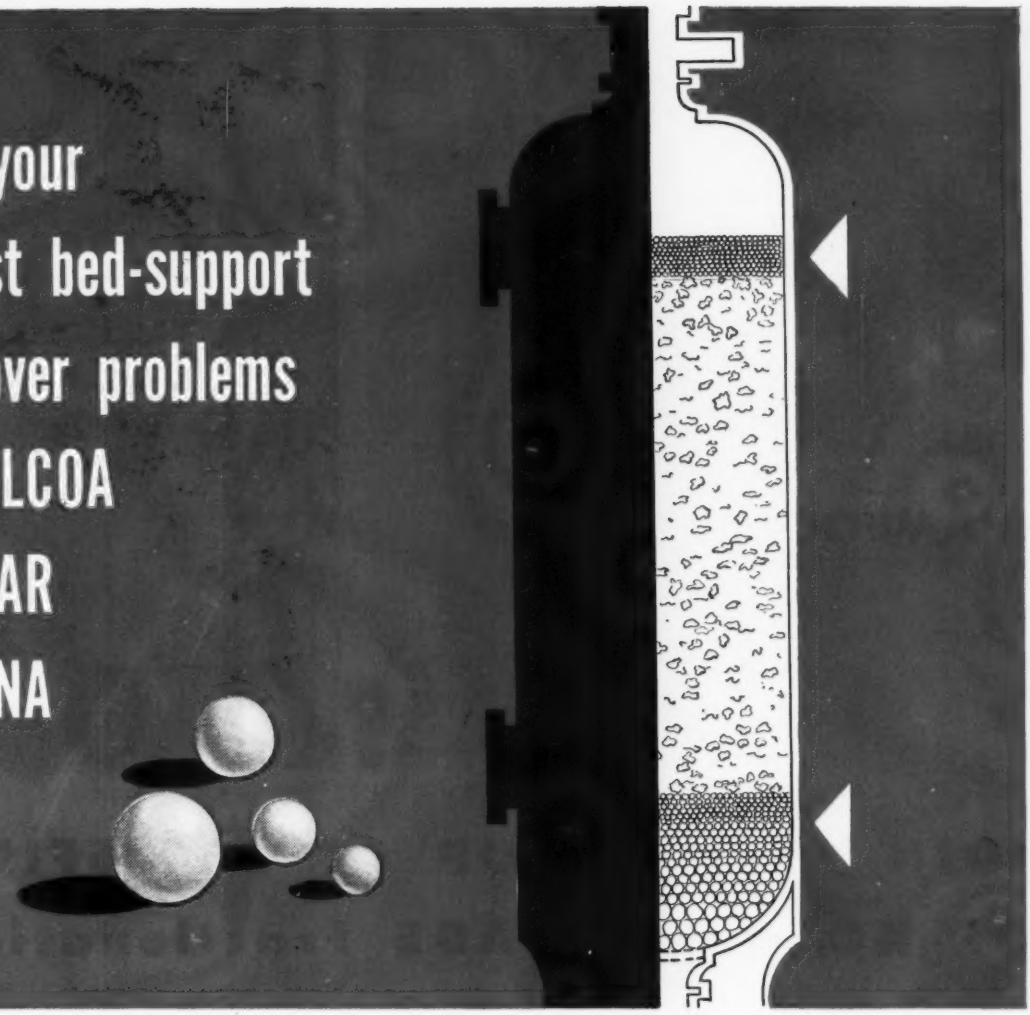

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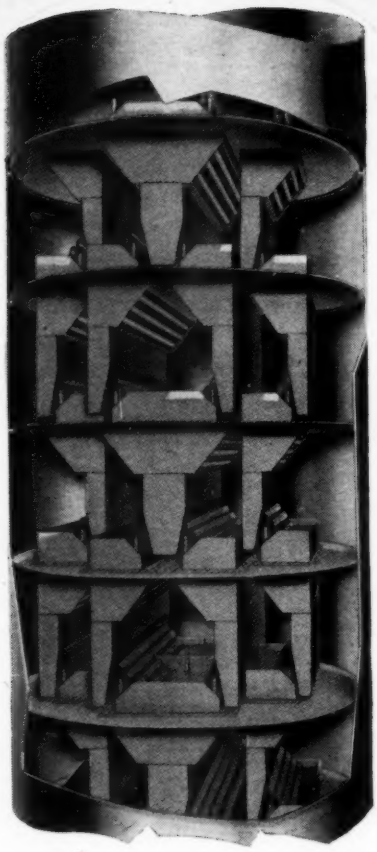

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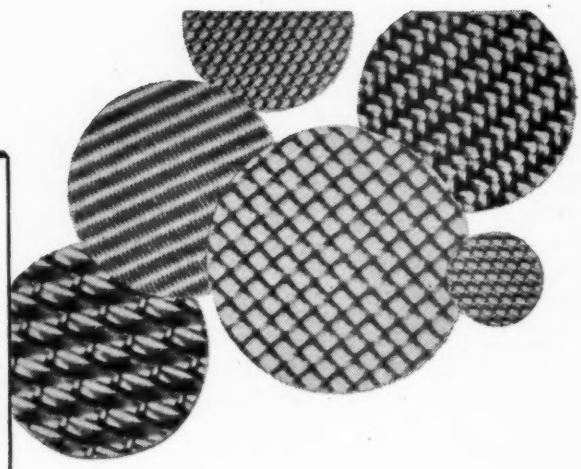

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And they won't . . . if they're made of Monel*, Nickel or Inconel* wire cloth.

For these are the "task metals" of industry.

Compare their advantages with any fabric or metal cloth now causing you trouble. They're rustless . . . corrosion-resisting . . . strong . . . tough. They endure abrasive wear. They withstand extremes of temperature. They protect the purity of the material being handled.

Many equipment manufacturers already have standardized on elements of Monel, Nickel or Inconel. Maybe your manufacturer is one of them. But maybe he isn't. So speak to him. Let him know you want the protection of the "task metals" wherever filters, strainers or screens are used.

For new equipment *or replacements, specify elements made of Monel, Nickel or Inconel. All weaves and meshes are available. Any practical shape or size can be fabricated. For more information plus the booklet,* **"ESTABLISHED WEAVERS OF WIRE CLOTH,"** *write to our Frank Bailey.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

***Monel**
Nickel
Inconel**

"Task Metals" for Industry

EMBLEM OF SERVICE
INCO
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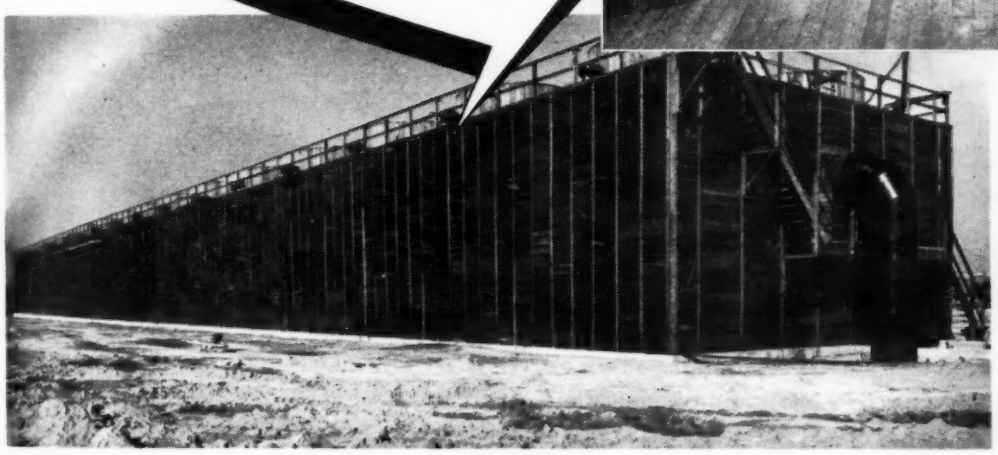
HERE IT IS! ...THE NEW MULTI-STAGE COOLING TOWER

...the Result of 10 Years of Research and EXHAUSTIVE TESTS

...FOR THE WORLD'S LARGEST LUBE PLANT



Top view of the 48'-0" wide x 408'-0" long x 28'-6" high, 34-cell, Multi-Stage Cooling Tower designed and erected for the World's Largest Lube Plant.

51,000 Gallons of water per minute . . . 3,060,000 gallons of water per hour . . 73,440,000 gallons of water per 24-hour day . . . cooled to a guaranteed temperature with this 34-cell Multi-Stage Induced Draft Cooling Tower.

NEW IN *ENGINEERING* . . . IN *PERFORMANCE* . . . *ADAPTABILITY*

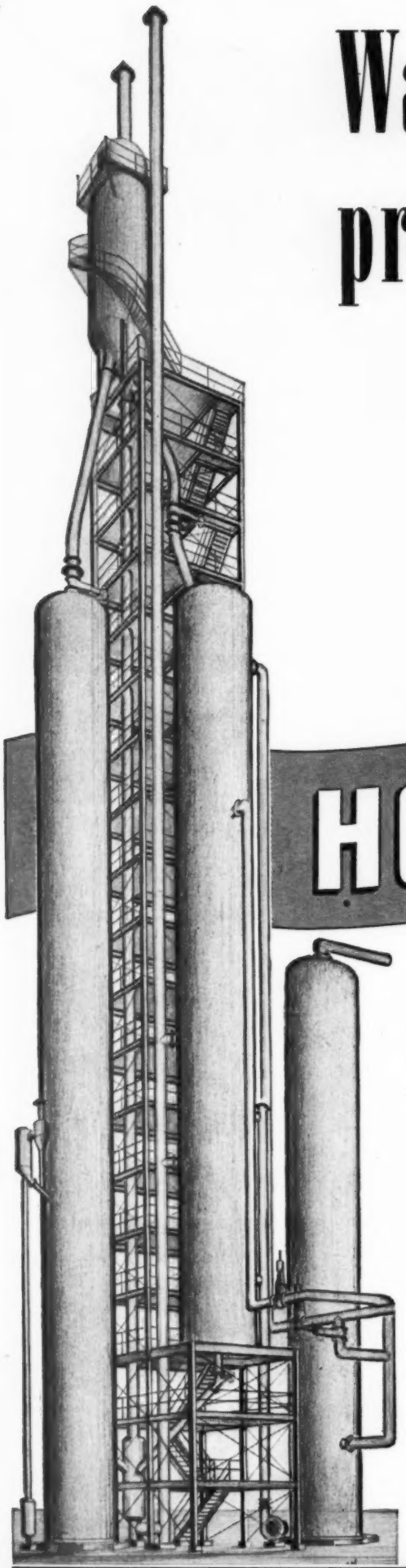
The above installation represents not only new designing to meet the requirements of the Petroleum and Chemical Industries, but is the results of 10 years of research and testing to meet the trends towards higher efficiency in Cooling Tower performance with increased temperature ranges and closer approach to the ambient wet bulb temperature. Water Cooling Equipment Company Engineers have created the above Multi-Stage Cooling Tower which attacks a hard cooling condition and solves the problem by breaking it into easier cooling conditions which are easier to accomplish. It is, in effect, two or more Cooling Towers operating in series within a SINGLE enclosure and operated with a SINGLE pumping of the water. The internal arrangement provides the serial flow of all the water from one bank of Filling to another, permitting intimate contact with separate streams of outside ambient air in counterflow through each bank. The IMPORTANT factor in this Cooling Tower is..a high water-to-air ratio is maintained making it possible to increase greatly the enthalpy of the outgoing air over that even theoretically possible with the single pass arrangement in either counterflow or cross-flow Cooling Towers. This is an engineering triumph.

TODAY'S WATER COOLING PROBLEMS CANNOT BE SOLVED WITH YESTERDAY'S METHODS

WATER COOLING EQUIPMENT CO.

8629 NEW HAMPSHIRE AVE. • ST. LOUIS 23, MO.

FULL INFORMATION UPON REQUEST



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THEN GET TO KNOW

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Houdriflow employs a new gas-lift principle for the catalyst circulation as well as many other improvements resulting in greater flexibility in operation. Projected data on a 10,000 BPD refinery operating on Houdriflow shows savings of more than $1,100,000 per year compared with older types of refining processes.

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SERVING THE PROGRESSIVE PETROLEUM INDUSTRY

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MARCH, 1949 Published by THE COOPER ALLOY FOUNDRY CO., HILLSIDE, N. J.
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DIFFUSERS FOR INDUSTRIAL BURNERS CAST IN HEAT RESISTANT STAINLESS STEEL

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CLAD METAL STEEL

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Nickel-Clad Stainless-Clad
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STEELS

SOLID METAL ADVANTAGES

All using Lukens Clad Steels

NICKEL-CLAD

STAINLESS-CLAD

INCONEL-CLAD

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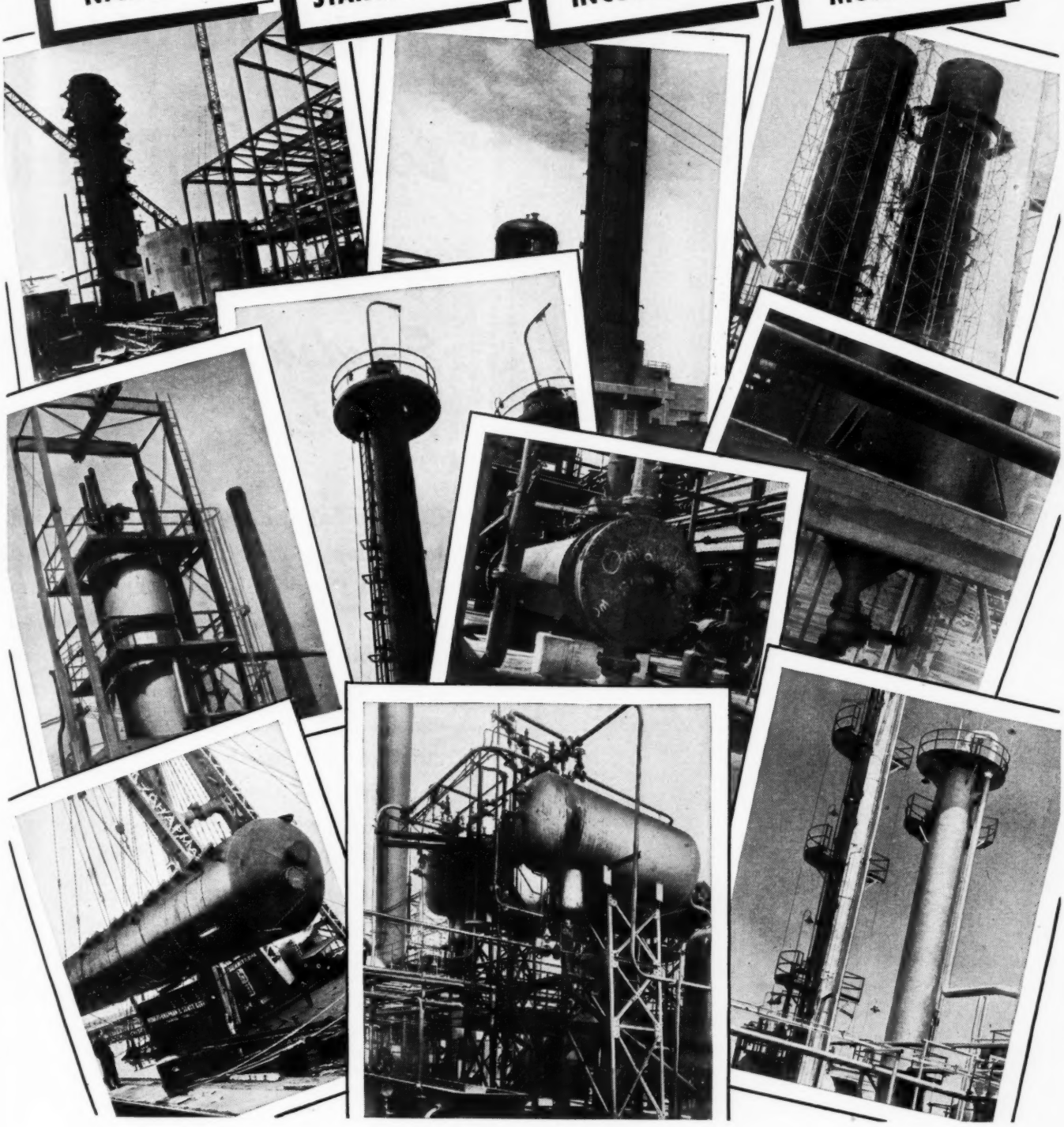


Bulletin 461 describes installations of Lukens Clad Steels in the Petroleum Industry. For a copy and for help in adapting these corrosion-resistant metals to your equipment, write Lukens Steel Company, 443 Lukens Bldg., Coatesville, Pa.

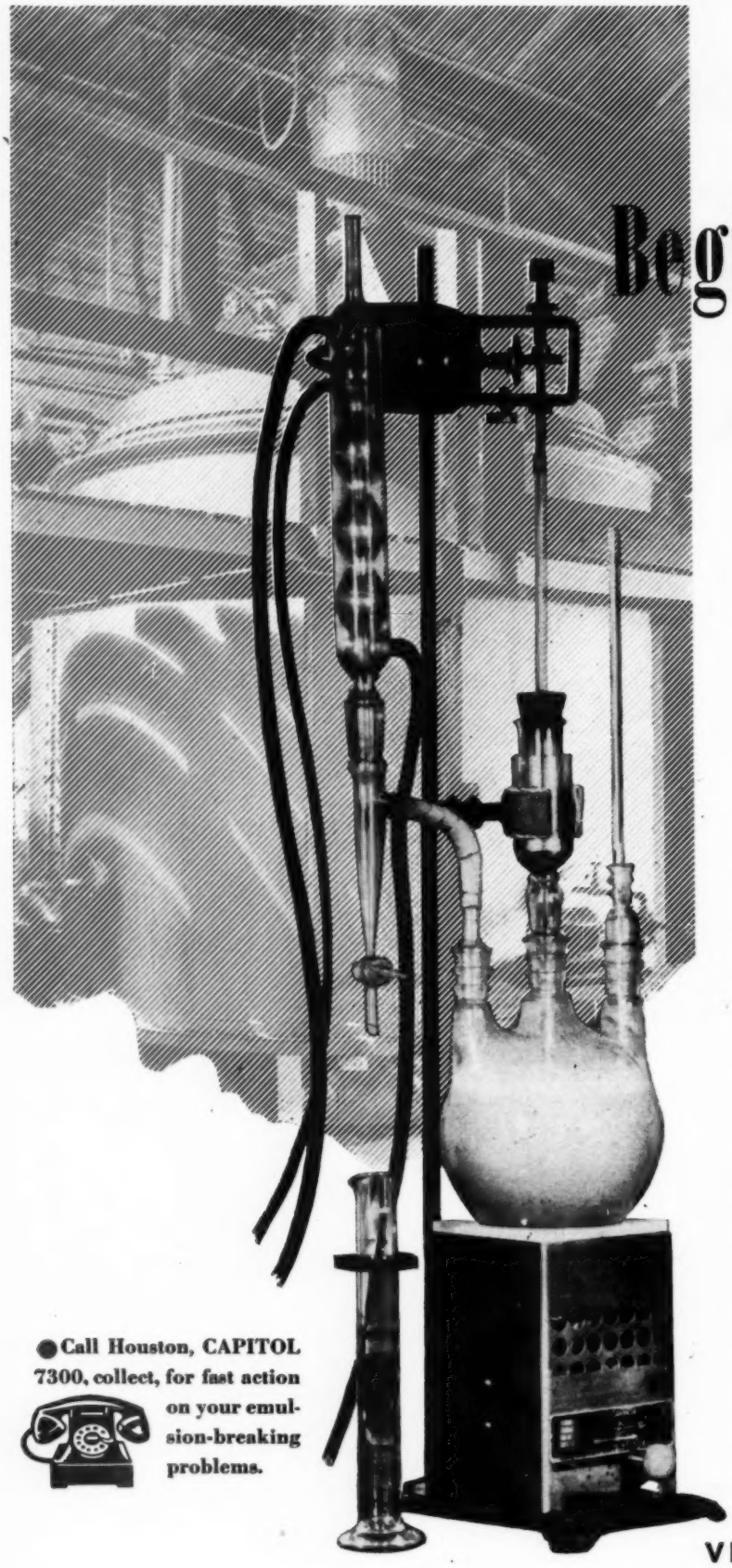
LUKENS

Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad

STEELS

★

WITH CLAD STEEL ECONOMY



Beginning of a New *Visco* Formula

to Solve Your Emulsion-Breaking Problems . . .

● **Visco Laboratory apparatus pictured here may contain a new or improved formula that will be a better answer to your emulsion-breaking problems. Visco has never been satisfied to slow down research for new and improved emulsion-breakers — even though fast, efficient emulsion-breaking at low cost per barrel of dry oil is what oil men have come to expect whenever they see the big blue Visco barrels.**

Whether your emulsion-breaking is simple or complex — Visco's modern service is the easy, *sure* way to get permanently successful results. Call today for a Visco Representative to give you full details.

● **Call Houston, CAPITOL 7300, collect, for fast action on your emulsion-breaking problems.**

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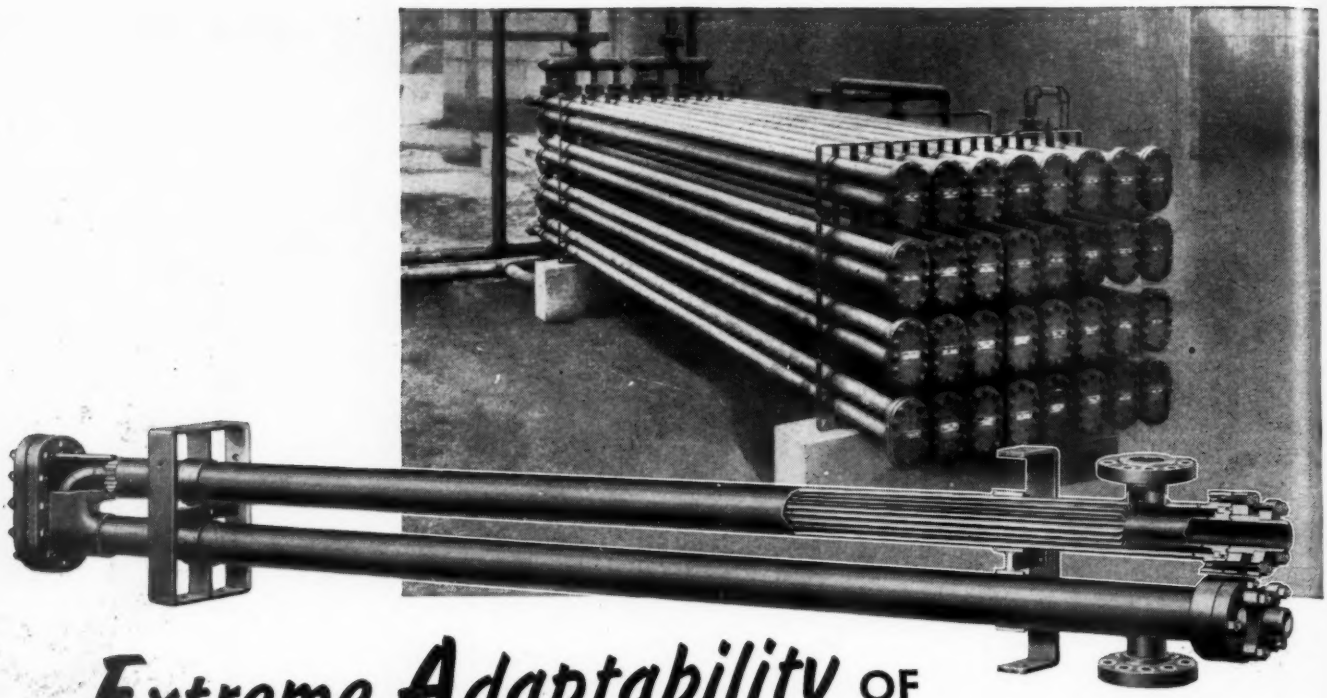

THE *Extreme Adaptability* OF

BROWN FINTUBE SECTIONAL HAIRPIN HEAT EXCHANGERS

Enables users to keep production abreast of changing market and seasonal conditions

● Unlike "bundle" type exchangers, which are custom built for a definite and fixed duty, Brown Fintube Sectional Hairpin Heat Exchangers give operating men almost unlimited flexibility to meet changing requirements. The capacity of the bank can be increased by adding additional sections to the original installation. Capacity can be decreased by valving off one or more of the parallel streams,—or reducing the number of sections in each stream. The entire bank can be changed from one duty, to another and totally different duty, by remanifolding the sections in different series-parallel arrangement. And the bank can even be disassembled, and the sections then reassembled as two or more smaller exchangers on different duties, in different plants.

Let us help you in adapting Brown Fintube Sectional Hairpin Heat Exchangers—with their many outstanding operating and maintenance advantages—to your next heat transfer requirement. The Brown Fintube Co., Elyria, Ohio. Sales engineers in the principal cities.

8 ADVANTAGES

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Sectional Hairpin
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1. Flanged Shell Seal and Flanged Union Head End Assembly.
2. Extreme Adaptability to Meet the Requirements of Changed Duties.
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7. The Brown Resistance Welded Integrally Bonded Fintube.
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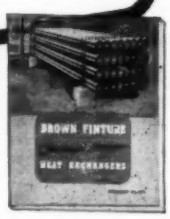


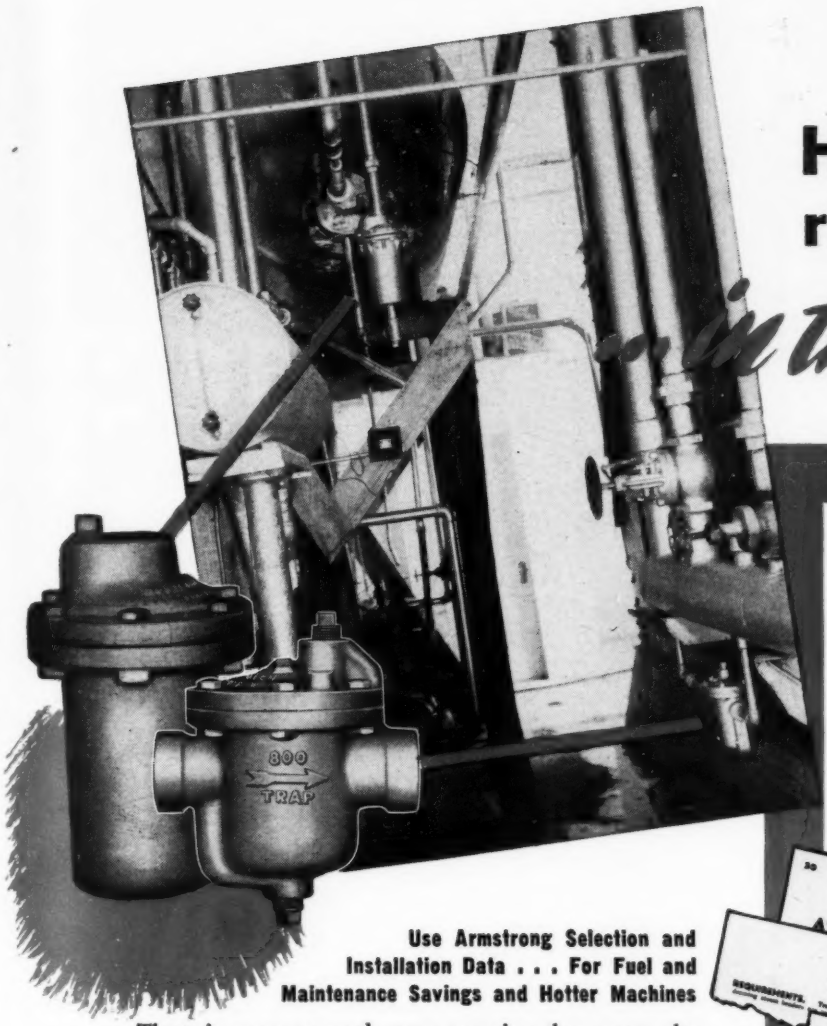
Write today for Bulletin No. 481. It gives full details

BROWN FINTUBE

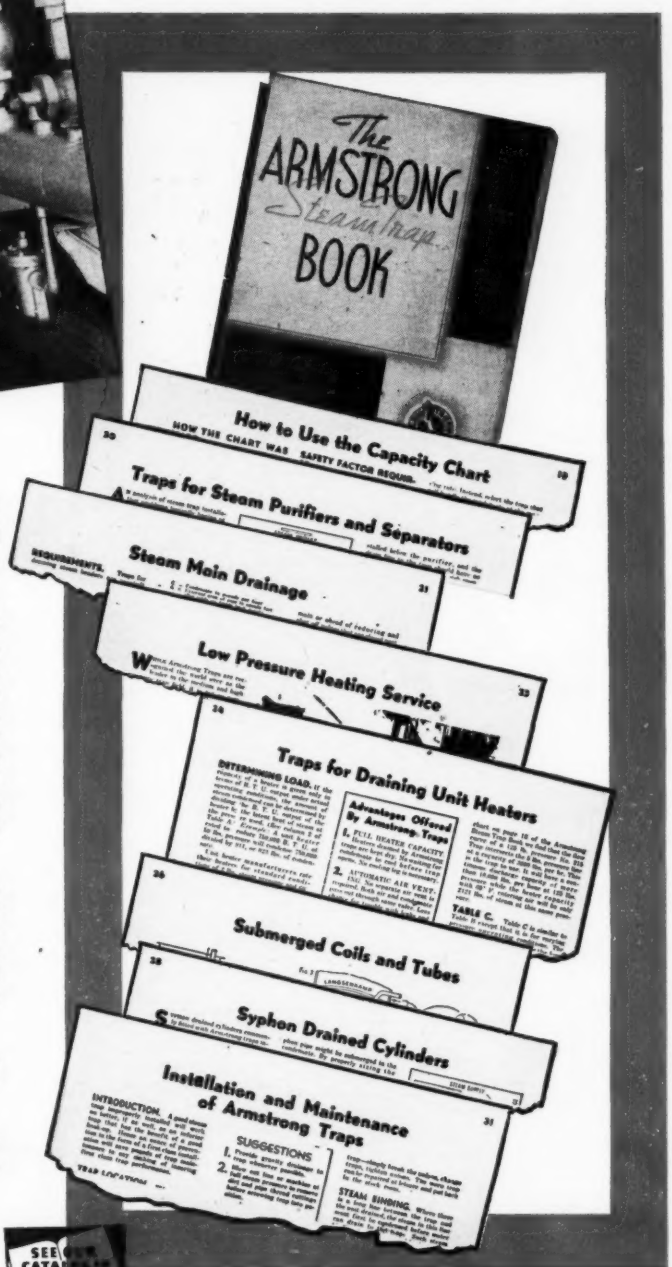
Sectional Hairpin

HEAT EXCHANGERS

RESISTANCE WELDED INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT TRANSFER PRODUCTS



How to get the right steam trap ...in the right place!


The ARMSTRONG Steam Trap BOOK
How to Use the Capacity Chart
Traps for Steam Purifiers and Separators
Steam Main Drainage
Low Pressure Heating Service
Traps for Draining Unit Heaters
Submerged Coils and Tubes
Syphon Drained Cylinders
Installation and Maintenance of Armstrong Traps

Use Armstrong Selection and Installation Data . . . For Fuel and Maintenance Savings and Hotter Machines

There is more to good steam trapping than meets the eye. For example, intelligent trap selection involves not only the normal condensate load but must take into account peak load and the amount of air to be handled as well. The Armstrong Steam Trap Book tells how to figure condensate loads, what to do about large amounts of air and how to determine trap capacity needed for various services. It follows up with actual hot-condensate capacities of Armstrong traps. (Some trap capacity figures are based on cold water ratings, misleading because any trap will handle more cold water than it will hot condensate).

Then, because a properly selected trap won't function efficiently if it is not correctly installed, The Armstrong Steam Trap Book provides complete data on installation practice. But, even the Steam Trap Book can't think of *everything*, so the Armstrong factory and trained sales representatives stand ready to give you a lift on the really tough trapping problems.

These are a few of the reasons why Armstrong traps can be sold on a basis of "COMPLETE SATISFACTION OR YOUR MONEY BACK."

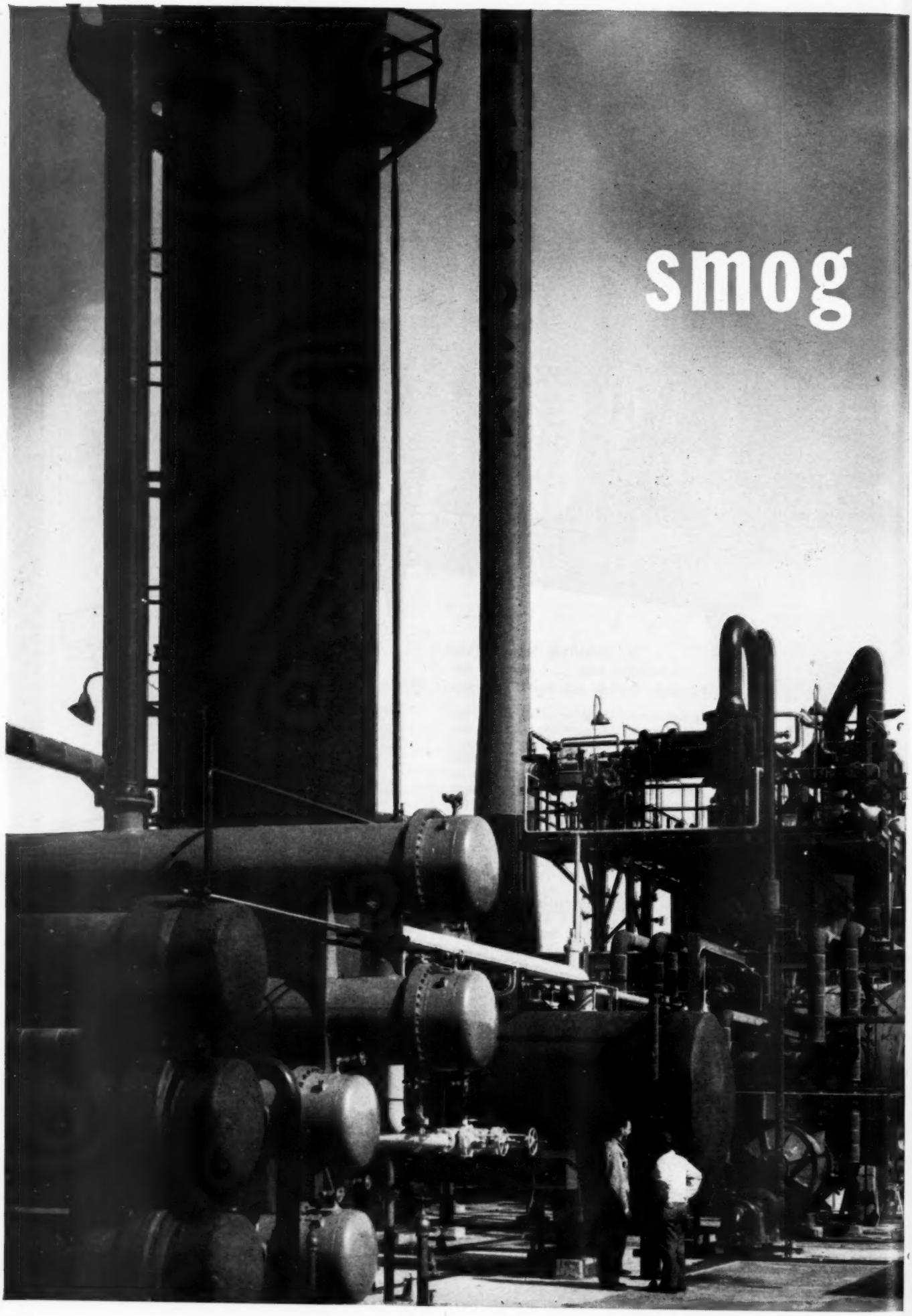
Send for a copy of the Steam Trap Book and plan now to modernize your condensate drainage system with Armstrong traps.

ARMSTRONG MACHINE WORKS

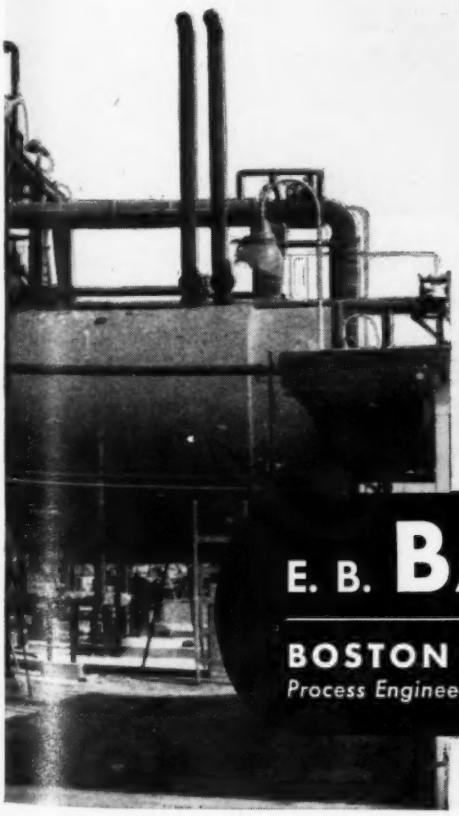
826 Maple St., Three Rivers, Michigan

SEE OUR CATALOG IN SWEET'S

ARMSTRONG STEAM TRAPS


smog

Eliminating at a profit



Pictured here is what we believe to be the first plant attacking the problem of atmospheric contamination by sulfur-bearing gases logically, effectively and profitably.

Hancock Chemical Company receives hydrogen sulfide removed from the fuel gases of nearby oil refineries and converts it to elemental sulfur which is sold for the manufacture of sulfuric acid.

The refiners benefit by the elimination of noxious fumes from stack gases, thereby improving maintenance and operation efficiency, and by the reduction of corrosion.

The return from the sale of the sulfur provides an attractive return on the plant investment.

The community benefits by the removal of many *tons a day* of sulfur from the atmosphere.

Initial operations of this plant have been so successful that plans are now being made for doubling the capacity of the installation.

Operating and investment cost data for plants of this type may be readily obtained from any Badger office.

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REDUCED REPAIR AND MAINTENANCE COSTS
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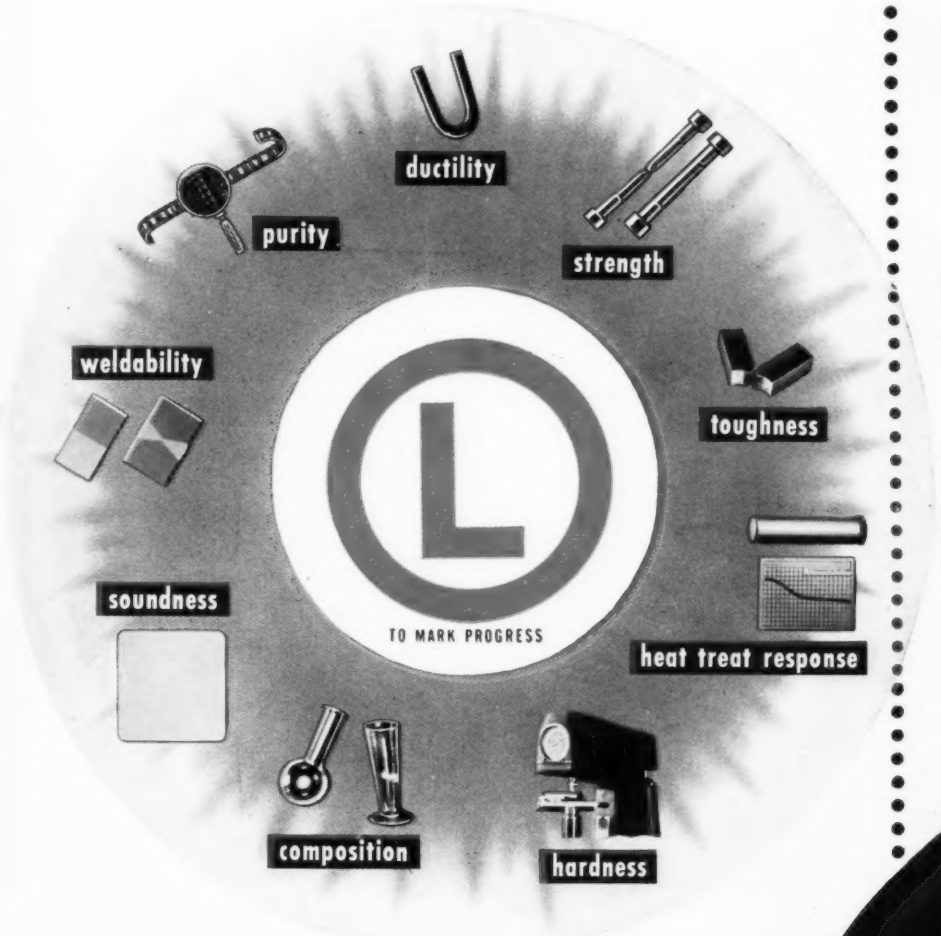

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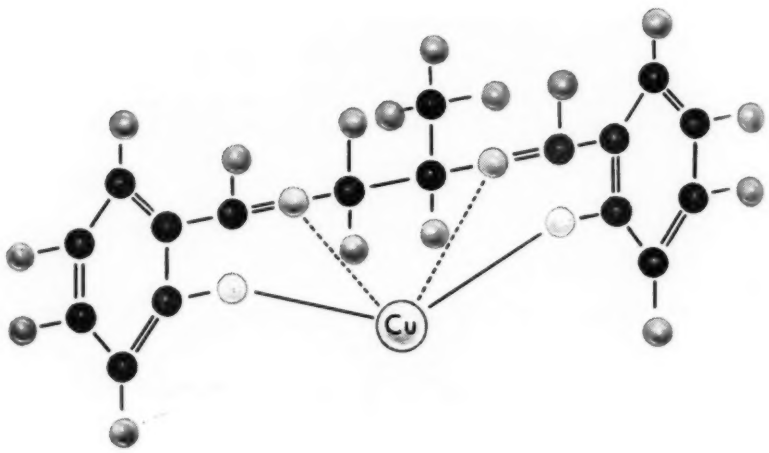
To *Improve Gasoline Storage Stability* use Du Pont METAL DEACTIVATOR

The Most Economical Additive for Controlling Copper Activity

Copper, when present in gasoline, has a decided pro-oxidant effect. It may be difficult to tell when copper is the cause of trouble because traces of dissolved copper picked up from brass condenser tubes, pump parts, valves and fittings are sometimes hard to detect by ordinary analytical methods. Yet even one part in several million parts of gasoline can cause a pronounced increase in oxidation.

In gasoline containing copper, the storage stability will be improved by adding Du Pont Metal Deactivator. This additive is highly effective, easy to handle, and the Deactivator response may be readily evaluated by induction period tests. The use of Du Pont Metal Deactivator may result in real savings because in every case overcoming the catalytic effect of copper is more economical with Metal Deactivator than an attempt at stabilization with antioxidants alone.

Ask your Du Pont Petroleum Chemicals Representative about Metal Deactivator, or write the nearest District Office for specific information.



Du Pont Metal Deactivator

(N:N^1-disalicylidene 1:2-diaminopropane) combines with dissolved copper to form a stable chelate as shown here. Chelate is inactive and has no pro-oxidant effect on gasoline.

DU PONT
REG. U.S. PAT. OFF.

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...THROUGH CHEMISTRY

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facts about treating?

FACT 1 Mercaptan *removal* is today's answer to deodorization problems.

FACT 2 Modernizing with the *Tannin Solutizer Process* for mercaptan removal yields "new refinery" economies in treating and blending your finished leaded gasoline.

FACT 3 *Conversion and operating costs* are extremely low.

FACT 4 The Tannin Solutizer Process is not *corrosive*.

FACT 5 The high efficiency of the Tannin Solutizer Process has been conclusively demonstrated during more than *five years* of commercial refinery operation.

FACT 6 The Tannin Solutizer Process does not affect the *stability* of the gasoline treated.

FACT 7 Complete Tannin Solutizer *process engineering* service is available—during the planning of your unit, at start-up, and thereafter if required.

We will welcome the opportunity to work with you on your specific problem. The Tannin Solutizer Process is licensed under the patent rights of Socony-Vacuum Oil Company and Shell Development Company.

SHELL DEVELOPMENT COMPANY, INCORPORATED

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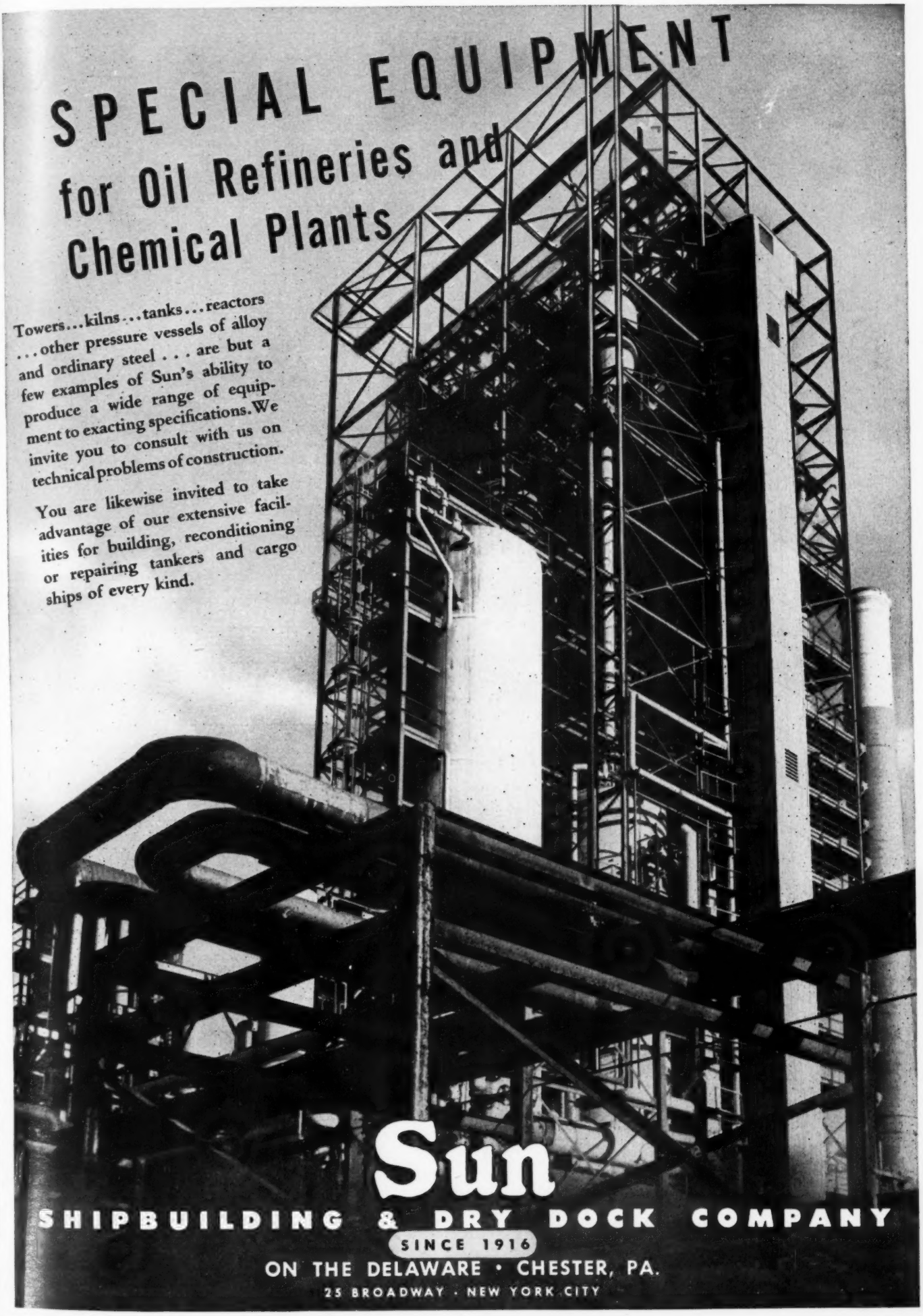
Pioneers in the Research and Development of Dry Chemical Fire Extinguishers

FIRE EXTINGUISHER DIVISION • MARINETTE, WISCONSIN

SPECIAL EQUIPMENT
for Oil Refineries and Chemical Plants



Towers...kilns...tanks...reactors ...other pressure vessels of alloy and ordinary steel . . . are but a few examples of Sun's ability to produce a wide range of equipment to exacting specifications. We invite you to consult with us on technical problems of construction.

You are likewise invited to take advantage of our extensive facilities for building, reconditioning or repairing tankers and cargo ships of every kind.

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SHIPBUILDING & DRY DOCK COMPANY

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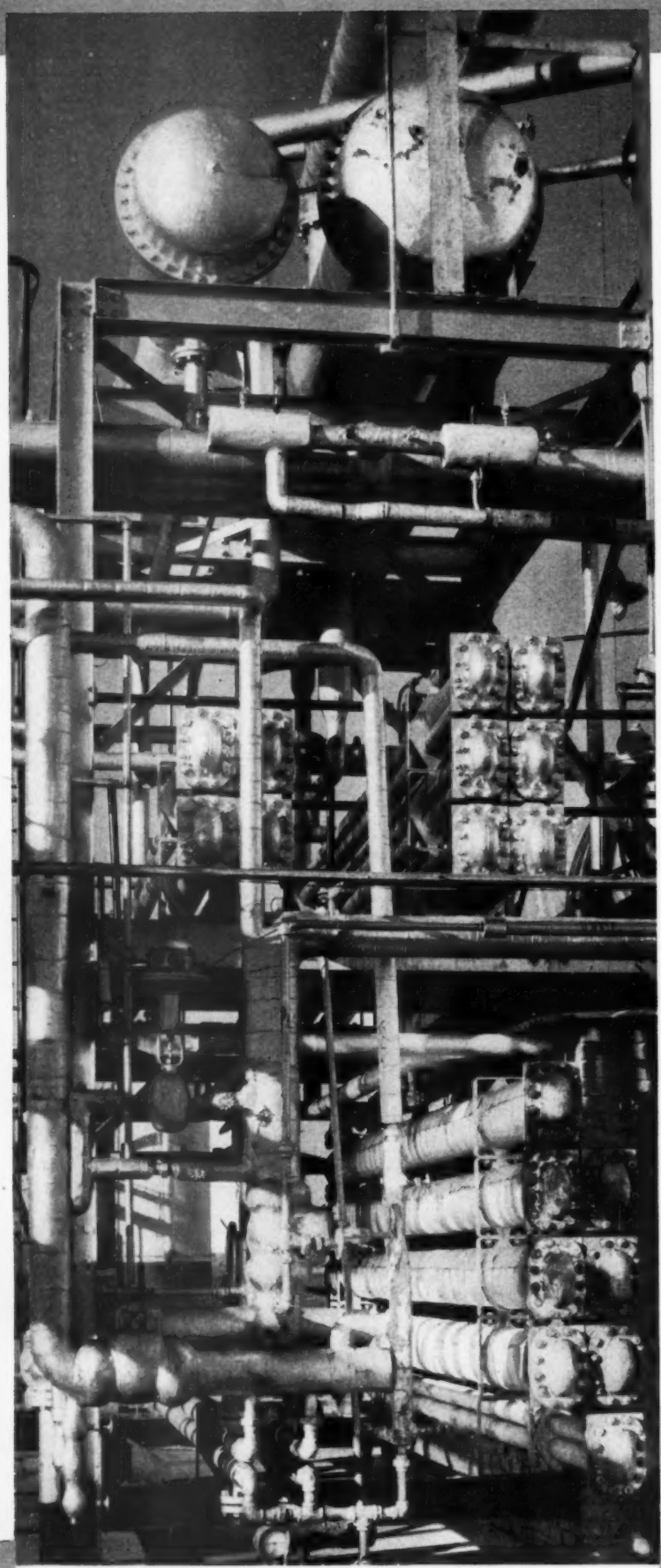
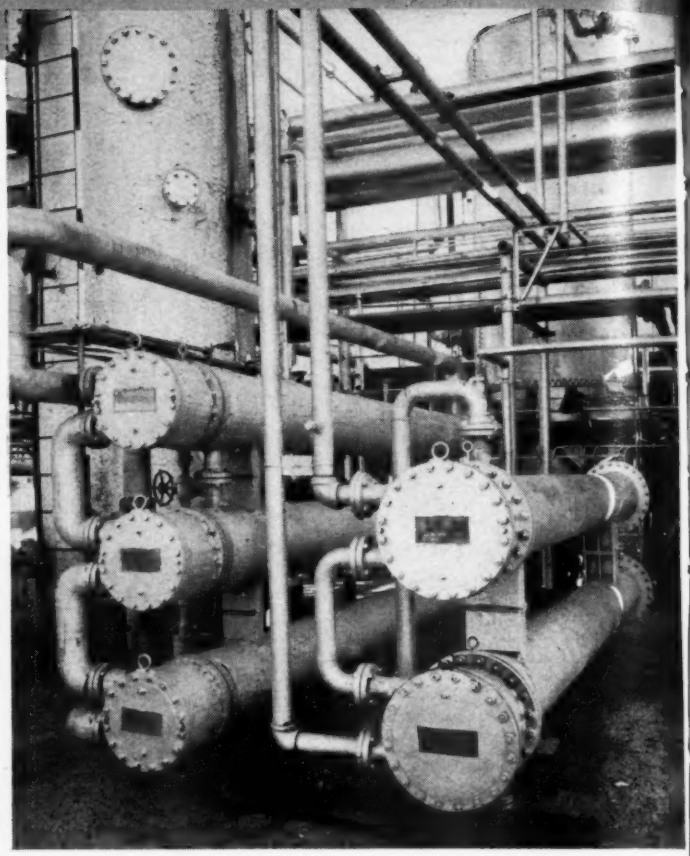
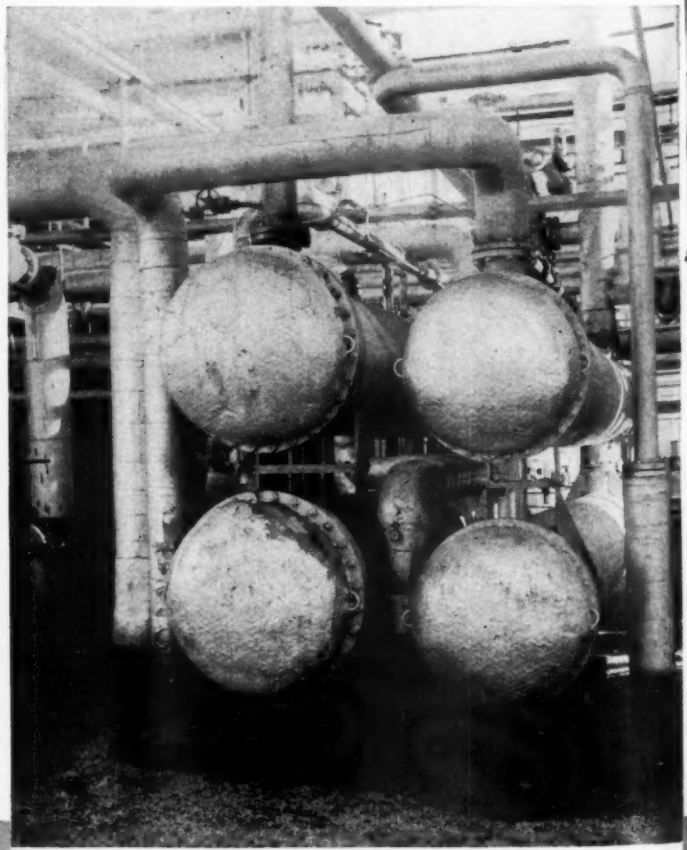


G-R Twin G-Fin Sections and Vapor-to-Feed Heat Exchangers



At left, G-R Heat Exchangers, and at right, G-R Gas Coolers



G-R Residue-to-Crude Heat Exchangers

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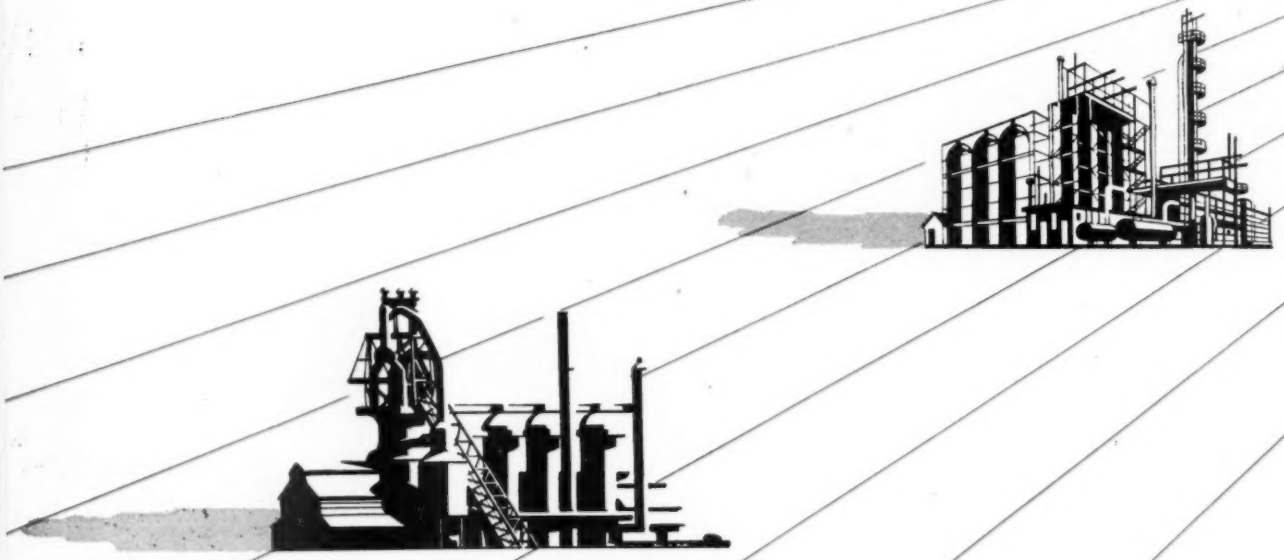

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PETROLEUM PROCESSING
MAY, 1949

Photo courtesy Goodyear Tire & Rubber Co.

Because the potential growth in the manufacture of such petrochemicals as butadiene and styrene is so closely tied in with the potential increase in production of synthetic rubber tires, PETROLEUM PROCESSING presents this survey on today's status of the synthetic rubber industry and its outlook for the future

'Cold' Rubber Success Means Business For Butadiene Plants in the Southwest

By WILLIAM C. UHL
Equipment Editor

INCREASED DEMAND IS FORESEEN for synthetic rubber during the next few years, which will mean greater utilization of the petroleum hydrocarbons from which it is manufactured. This is of particular interest to the Southwest, because approximately 82% of the existing national capacity for producing butadiene and 54% of the capacity for styrene is located there.

The anticipated increase in the use of synthetic rubber is due chiefly to the recent successful development of a low temperature process for polymerizing general purpose synthetic rubber—GR-S type—greatly improving its qualities. The "cold" rubber product of this new process improvement has been heralded as "an important milestone in synthetic rubber technology," making it a definite competitor with natural rubber.

By the end of 1949, approximately 53% of the rated capacity of the active synthetic rubber co-polymer plants will have been converted to the production of cold rubber. Of the nine co-polymer plants still active in the synthetic rubber program, six are in the Southwest—Louisiana and Texas area. They will be manufacturing 180,000 long tons per year of low temperature GR-S at the end of this year. Total production rate for the entire country at that time will be 198,000 long tons annually, and will include two small plants, one in California and one in Connecticut.

The actual total quantity of cold rubber produced during 1949 will be about 14,000 long tons, according to most conservative estimates today. The current monthly rate is approximately 1500 long tons, and conversion of plants is not expected to be complete until midsummer or early fall. A complete report on the status of all plants in the government synthetic rubber program is shown in Table 1.

Preliminary tests by government, petroleum, and rubber industry engineers have indicated that in some ways, particularly the property of tread wear in passenger car tires, cold rubber surpasses natural rubber by a good margin. While agreeing that cold rubber is better than standard GR-S, technologists differ in opinion as to how much better it is than natural rubber.

Major differences between standard and cold GR-S, in addition to product properties, are: (1) lower processing temperature, 41° F. being used presently in place of the conventional 122° F.; (2) longer processing cycle, resulting in an overall reduction of yield per unit time, 13 to 15 hrs. reaction time for standard as against 20 to 22 hrs. for cold; (3) use of so-called activator catalysts in addition to the normal oxidizing agents; and (4) use of improved carbon blacks in the final compounding step, said to aid materially in effecting superior tread wear.

Conversion of the presently active polymerization plants to the cold rubber process consists mainly in the addition of refrigeration, compressors, insulation, and the like to the existing process equipment. One of the new catalysts being used is a form of sugar, which may add slightly to the cost of the product. How-

ever, overall costs, it is reported, will be very little greater than for standard GR-S.

The new and improved carbon blacks are those developed by Phillips Petroleum Co. Produced by the furnace process from a liquid hydrocarbon charge stock, rather than the conventional channel process using natural gas, these new blacks are said to give increased abrasion and wear resistance, particularly to the cold rubber, in which they have been compounded with the least processing difficulties. Although there is general agreement among rubber engineers that the new furnace blacks could also provide an equivalent improvement in natural rubber products, processing the natural material with furnace instead of channel blacks has presented a number of problems, not as yet solved.

Predictions Difficult

Just what effect cold rubber will have on the demand for petroleum hydrocarbons used in the manufacture of synthetic rubber is as yet difficult to predict. Both standard GR-S and the new cold material use the same percentages of petroleum hydrocarbon feedstock—71% butadiene to 29% styrene. There is a feeling by some technologists, however, that a revised formula incorporating as much as 90% butadiene would give improved truck tires for the military, particularly for use in cold climates.

The demand for petroleum hydrocarbons will therefore be in direct proportion to the demand for cold rubber. This will be affected by a number of factors.

1. Price trends of natural rubber.

2. Public acceptance of the improved, cold GR-S, especially in the largest volume product of the rubber industry—passenger car tires.

3. Changes in the status of the industry itself by the middle of 1950; that is, will there be a complete return of the synthetic rubber industry to private enterprise status when the present Rubber Act—P. L. 469, March 31, 1948, 80th Congress—terminates?

A program for the disposal to private industry of all war-built, government-owned plants was submitted April 1, 1949, to the President and the Congress by the Reconstruction Finance Corp., in accordance with directives of the 1948 Rubber Act.

4. Probable increase in product improvements and processing technology as a result of the recent cessation of the war-time rubber patent pooling arrangements.

With respect to the factor of price, the history of natural rubber since the end of the war has been fairly steady, maintaining a close adherence to the established prices on the synthetic product of around 18.5c per lb. Natural rubber would seem to be preferred to standard GR-S, as indicated in the Office of Domestic Commerce figures on annual consumption, shown in Fig. 1.

Natural Rubber Leveling Off

Percentagewise, consumption of natural rubber has increased rapidly since 1945. Best estimates for 1949 indicate a leveling off, due in part it is believed, to government stockpiling. Quantities actually in stockpiling inventories cannot be revealed for national security reasons. The increase in natural rubber consumption was anticipated with the return to domestic tire manufacturers of an open channel of supply from the foreign rubber plantations.

However, in deciding whether there is actually a preference for natural over synthetic rubber, the following facts must be considered:

First: the recently enacted Rubber Act of 1948 requires; 1) annual consumption of at least 200,000 long tons of GR-S plus 22,000 long tons of special purpose, a total of 222,000 long tons of synthetic rubber; and 2) annual production of at least one-third of 665,000 long tons, or approximately the same quantity.

Secondly: rated capacity of the active copolymer plants in the government program is at least 375,000 long tons annually, as indicated in Table 1. Actual quantities being produced are known to be well in excess of that rated capacity—in the range of 25% greater. (Exact information on these so-called demonstrated capacities is, in part, restricted information).

It follows then that a substantial demand for synthetic rubber must exist, because both actual production and actual consumption of the material is well over the minimum required quantities.

Now, for the first time it is believed generally that synthetic rubber is in a good competitive position with respect to the natural product. The optimism for the prospects of cold rubber is felt not only by officials in the Office of Rubber Reserve, but also by rubber and petroleum company scientists, notably those who participated in its development.

This optimism can best be described as the "if" type. Most authorities agree that there are too many variables and unknown factors in the picture today for accurate predictions.

Officials with the Office of Rubber Reserve stated recently: "This new synthetic rubber polymerized at low temperatures, sometimes referred to as cold rubber, has shown a 25% improvement over standard GR-S when used as a tire tread stock. New carbon blacks for special use in synthetic rubber have been developed by private industry to improve the treadwear performance of synthetic rubber an additional 25%. Thus, the combination of the new synthetic rubber and the new carbon blacks have resulted in tire treads of substantial performance improvement over natural rubber."(1)

Oil Man Optimistic

Dr. W. B. Reynolds, chief of synthetic rubber division, research department, Phillips Petroleum Co., is definitely optimistic concerning the future of cold rubber. He said recently:

"In addition to sound economic and military considerations justifying an American synthetic rubber industry there are strong present indications that synthetic rubber is winning the quality race. The new cold rubber, combined with the new high-abrasion furnace black, is producing better tire treads than have ever been made before. A decided improvement over natural rubber is obtained in both wear and resistance to cracking, chipping, and cutting. This latter especially is proving a boon to the manufacturers of the new low pressure tires."(2)

B. F. Goodrich Co., credited with an important pioneering role in the development of synthetic rubber, feels that the optimism for cold rubber must be shaded somewhat because tread wear tests to date are not conclusive. Road tests have not been made under all possible conditions of weather, road, and driver differences. A company spokesman told PETROLEUM PROCESSING that the government has done the rubber industry a disservice in claiming the high improvements in tread wear. The improvement over standard GR-S is definite, Goodrich states, and the improvement over natural rubber is likely to be in the range of 5%.

A certain portion of Goodrich tires are being made and sold with cold rubber in the tread stock. Records are being kept by the company of

How to Obtain Copies Of Disposal Plan

Copies of the RFC program for disposal of synthetic rubber plants may be obtained from the U. S. Government Printing Office, Washington 25, D. C. The full title of the booklet is "Report with Respect to the Development of a Program for Disposal of Government - Owned Rubber - Producing Facilities," dated April 1, 1949.

the tire serial numbers. However, buyers, and even dealers, do not know which of the tires contain cold rubber. It will obviously be some time before a conclusive report on the tire mileages obtained can be made.

Cautious optimism is echoed by another leading rubber scientist, Dr. R. P. Dinsmore, vice president in charge of research and development, Goodyear Tire & Rubber Co., who stated recently:[3]

"The (cold) rubber gives a very marked improvement in tread wear as against the old synthetic—perhaps 30%. This would raise it to, or somewhat above, the level of natural rubber. However, synthetic has been subject to tread-cracking and this fault develops in slow, hot-weather testing, where we have but little experience as yet. The tendency to skid under wet, winter conditions is also yet to be determined. These two factors may enhance or off-set the tread wear advantage over natural rubber. There can be no doubt, however, of the improvement over the old synthetic."

On the other hand, actual demand for cold rubber continues to increase. Based on requests to the Office of Rubber Reserve, it has been stated that demands will probably continue to exceed supply of cold rubber for at least the next 12 to 18 months.[4]

It has been estimated, according to this same source, that about three out of every 100 tires sold in 1949 will contain some cold rubber. A number of the smaller tire companies have been going "all-out" on the use of cold rubber.

Any consideration of the general outlook for cold rubber and the synthetic rubber industry itself cannot ignore the Rubber Act of 1948, which became effective April 1, 1948, and expires on June 30, 1950. Essential directives of this law, P. L. 469, are:[5]

1. Retention in production or standby condition, capacity for production annually of 600,000 long tons general purpose and 65,000 long tons special purpose synthetic rubber. Facilities in government or privately operated plants must produce at least one-third of the 665,000 long tons annually. Plants outside the required capacity may be disposed of permanently with the approval of the National Security Resources Board.

2. Requires consumption of 200,000 long tons of general purpose and

TABLE 1—Status of Plants in Government Synthetic Rubber Program, as of January 1, 1949

Operator and Location	Rated Capacity, long tons per year: Active	In cold GR-S, end of 1949	Standby	Surplus	Sold
COPOLYMER (GR-S) PLANTS					
B. F. Goodrich Co., Port Neches, Texas	60,000	30,000[1]	.....	.....	.....
B. F. Goodrich Co., Port Neches, Texas[2]	.....	.....	60,000	.....	.....
B. F. Goodrich Co., Louisville, Ky.	.....	.....	.....	.....	60,000
Copolymer Corp., Baton Rouge, La.	30,000	30,000	.....	.....	.....
Firestone Tire & Rubber Co., Akron, O.	30,000	none	.....	.....	.....
Firestone Tire & Rubber Co., Lake Charles, La.	60,000	30,000	.....	.....	.....
General Tire & Rubber Co., Baytown, Tex.	30,000	30,000	.....	.....	.....
Goodyear Synthetic Rubber Corp., Houston, Tex.	60,000	30,000	.....	.....	.....
Goodyear Synthetic Rubber Corp., Los Angeles	30,000	15,000	.....	.....	.....
Goodyear Synthetic Rubber Corp., Los Angeles[3]	.....	.....	45,000[4]	.....	.....
Goodyear Synthetic Rubber Corp., Akron, O.[5]	.....	.....	.....	30,000	.....
National Synthetic Rubber Corp., Louisville, Ky.	.....	.....	30,000	.....	.....
U. S. Rubber Co., Borger, Texas	45,000	30,000	.....	.....	.....
U. S. Rubber Co., Naugatuck, Conn.	30,000	3,000	.....	.....	.....
U. S. Rubber Co., Institute, W. Va.	.....	.....	90,000	.....	.....
Totals	**375,000**	**198,000**	**225,000**	**30,000**	**60,000**
BUTYL (GR-I) PLANTS					
Esso Standard Oil Co., Baton Rouge, La.	25,333	.....	.....	.....	.....
Esso Standard Oil Co., Baton Rouge, La.	.....	.....	12,667	.....	.....
Humble Oil & Refining Co., Baytown, Tex.	30,000	.....	.....	.....	.....
Totals	**55,333**	.....	**12,667**	.....	.....
NEOPRENE (GR-M) PLANT					
E. I. du Pont de Nemours & Co., Louisville, Ky.	.....	.....	.....	.....	**60,000**
BUTADIENE PLANTS (Petroleum)	**Rated Capacity, SHORT Tons per year:**				
Cities Service Refining Co., Lake Charles, La.	55,000	.....	.....	.....	.....
Esso Standard Oil Co., Baton Rouge, La.	.....	.....	15,000	.....	.....
Esso Standard Oil Co., Baton Rouge, La.[6]	.....	.....	.....	.....	6,800
Humble Oil & Refining Co., Baytown, Tex.	30,000	.....	.....	.....	.....
Humble Oil & Refining Co., Ingleside, Tex.	.....	.....	.....	.....	7,000
Lion Oil Co., El Dorado, Ark.	.....	.....	.....	.....	3,500
Neches Butane Products Co., Port Neches, Tex.	100,000	.....	.....	.....	.....
Phillips Petroleum Co., Borger, Tex.	56,200	.....	.....	.....	.....
Shell Chemical Corp., Los Angeles, Calif.	.....	.....	55,000	.....	.....
Sinclair Rubber Co., Inc., Houston, Tex.	.....	.....	50,000	.....	.....
Southern California Gas Co., Los Angeles, Calif.	.....	.....	30,000[7]	.....	.....
Standard Oil Co. of Calif., El Segundo, Calif.	18,000	.....	.....	.....	.....
Sun Oil Co., Toledo, Ohio	.....	.....	.....	15,000	.....
Taylor Refining Co., Corpus Christi, Tex.	.....	.....	.....	.....	2,600
Totals	**259,200**	.....	**120,000**	**15,000**	**19,900**
BUTADIENE PLANTS (Alcohol)					
Carbide & Carbon Chemicals Corp., Louisville, Ky.	.....	.....	60,000	.....	.....
Carbide & Carbon Chemicals Corp., Institute, W. Va.	.....	.....	.....	.....	80,000
Koppers Co., Inc., Kobuta, Penna.	.....	.....	80,000	.....	.....
Totals	.....	.....	**140,000**	.....	**80,000**
STYRENE PLANTS					
Carbide & Carbon Chemicals Corp., Institute, W. Va.	.....	.....	.....	.....	25,000
Dow Chemical Co., Los Angeles, Calif.	25,000	.....	.....	.....	.....
Dow Chemical Co., Velasco, Tex.[6]	.....	.....	.....	.....	50,000
Koppers Co., Inc., Kobuta, Penna.[6]	.....	.....	.....	.....	37,500
Monsanto Chemical Co., Texas City, Tex.[6]	.....	.....	.....	.....	50,000
Totals	**25,000**	.....	.....	.....	**162,500**

(1) These figures are not in addition to active rated capacity shown in first column. For example: one-half of Goodrich Port Neches plant will be producing cold rubber at year-end, all of Copolymer Corp. Baton Rouge plant, one-half of Firestone Lake Charles plant, etc.
(2) Formerly operated by Firestone Tire & Rubber Co.
(3) One 30,000-long ton unit formerly operated by U. S. Rubber Co.
(4) One-half of one standard 30,000-long ton unit never completed.
(5) Considered surplus to the requirements of the Synthetic Rubber Program and transferred to the Office of War Activity Liquidation of the RFC for disposal.
(6) Sold subject to Government requirements.
(7) Crude butadiene purified in Shell Chemical Corp. facilities.

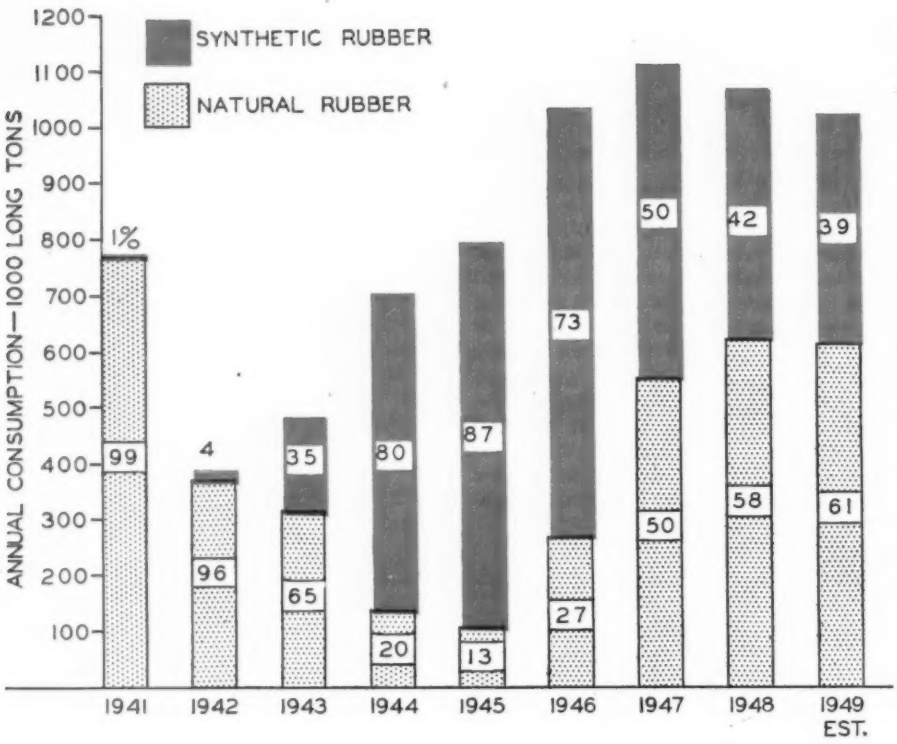

Fig. 1—Annual consumption of rubber, U. S., 1941 to 1949. Height of bar indicates quantities; shaded portions indicate percentages of natural and synthetic

22,000 long tons special purpose synthetic rubber annually.

3. Authorizes the President to exercise allocation, specifications, and inventory controls of natural and synthetic rubber and to insure the consumption of synthetic rubber in the amounts specified.

4. Directs the establishment of adequate government research and encourages private research.

5. Directs the termination of the war time rubber patent pooling arrangements.

The law is not binding on any future arrangements with respect to when the synthetic rubber industry should be returned to private industry. It requires merely that a program be presented to Congress in 1950 for disposal to private industry of the Government-owned facilities.

6. Disposal program should be carried out in manner to protect the interest of small users who are not purchasers. This, it was said, might be done by selling facilities to manufacturers not now using synthetic rubber, or to combination of small users, thus providing sources of supply other than from major competitors. However, future legislation should make plain that the Attorney General shall advise RFC as to whether any proposed disposal is in conflict with the anti-trust laws.

As each plant is sold, the program sets forth that the government should decrease "in substantial relation" its own program. "When the total requirements can be obtained from private industry," it was added, "the government should then cease entirely its production of synthetic rubber."

A key statement in the plan, however, emphasizes the possibility that the government may stay in the business of making synthetic rubber. It says the government's right shall *not* be limited "to produce rubber in amounts necessary to permit compliance with any required use, if sufficient rubber is not available from private suppliers, or in periods of national emergency as subsequently enacted by the Congress, or determined and announced by the President."

That program was described in a report published April 1, 1949.(6) Drawn up by the Inter-Agency Disposal Committee under the Reconstruction Finance Corp., the plan calls for the sale of all plants to private business on a basis that would assure disposal to "as many different segments or types of American industry as practicable." Facilities involved include nine butadiene and three butyl rubber plants either now or formerly operated by oil companies.

As submitted to Congress, the program recommends enactment of legislation authorizing the President to proceed with the transfer of facilities to private industry along the following lines:

1. Attempt should be made to sell facilities within six months after bidding is started.

2. All facilities should be sold at "fair value" rather than construction costs, following a physical appraisal and consideration of the "highest and best" use of facilities, adjusted to reflect conditions peculiar to each respective facility. Leasing of facilities may be necessary as a temporary expedient, but lease terms should be less favorable than sales terms.

3. Facilities which constitute the plant capacity required for national security and not sold to private industry should be maintained by the government in such condition that in event of a national emergency the facilities may be reactivated within a minimum time.

4. The President should be empowered to require continued usage of synthetic rubber, if this is necessary to maintain markets for synthetic rubber.

5. Facilities not sold to private industry for the production of synthetic rubber and not necessary to rubber production requirements of the United States should be sold at terms other than those contemplated in the disposal program, provided that facilities sold on more favorable terms shall not be used in synthetic rubber production. However, preference should be given to disposal for purpose for which plant was constructed.

One point in the 1948 Rubber Act, however, is seen by private industry as being a definite indication of progress. That is the directive that the war time patent pooling arrangements and agreements be terminated.

Return to competitive private research, made mandatory by the Rubber Act last April, has taken until the present time to consummate. The immediate cessation of further patent pooling and technical information under war time agreements will, according to John L. Collyer, president, B. F. Goodrich Co., "furnish the incentive needed for discovery and production of newer and better man-made rubbers."

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(1) "Synthetic Rubber Quality Shows Improvement," G. B. Hadlock, Executive Director; John T. Cox, Jr., and O. W. Burke, Jr., Deputy Directors, Office of Rubber Reserve, Reconstruction Finance Corp.; *Chem. & Engrg. News*, 27, 1, pp. 27-28, Jan. 3, 1949.

(2) "Tires from Petroleum," speech by W. B. Reynolds, Phillips Petroleum Co., before the Cosmopolitan Club, Washington, D.C., Feb. 24, 1949.

(3) "Synthetic Rubber Status," by R. P. Dinsmore, Goodyear Tire & Rubber Co.; Public Relations Dept. News Release No. 02913, Jan. 5, 1949.

(4) Editorial, *Rubber Age*, Feb., 1949.

(5) The Rubber Act of 1948—P. L. 469, March 31, 1948, 80th Congress of the U. S. of America.

(6) "Report with Respect to the Development of a Program for Disposal of the Government-Owned Rubber-Producing Facilities," Reconstruction Finance Corp., April 1, 1949.

THE MASS SPECTROMETER— A Tool for the Petroleum Processor

By JOHN F. KINDER and RICHARD WERTZLER
Research and Development Department, Sinclair Refining Co.

The mass spectrometer is capable of rapid and accurate analysis of many refinery streams and other mixtures encountered in petroleum processing and research. Types of materials which have been analyzed by one refinery include streams of C_1 through C_5, pilot plant samples through C_7, miscellaneous aromatics, flue gases, compounds containing sulfur, and others. Average elapsed time of 1½ hours per sample is shown to compare favorably with 6 to 8 hours required by some older methods.

While technically trained personnel are needed for supervision of a mass spectrometer laboratory, instrument operation and computations can be handled by high school graduates after a training period of several weeks. Methods of handling samples, the instrument, maintenance, and calculations which have been proved satisfactory by three years of experience are described.

THE really outstanding usefulness of the mass spectrometer is underscored by the fact that fifty of them have been absorbed into the petroleum industry in the few years they have been available commercially. Its great value stems from the ability to perform with great rapidity analyses of complex gas and liquid mixtures despite chemical and physical similarities of the components.

The Sinclair Refining Co. now utilizes three mass spectrometers for control of refinery and pilot plant operations and in conjunction with research. The first of these, a Consolidated Engineering Corp. (1) model 21-101 (subsequently modernized) was installed at our East Chicago, Indiana, location in 1945 and has been in continual operation since that time. From then until mid-1948 this particular instrument was used both for routine analyses and research on analytical methods by the Research and Development Dept. Late in 1947, the Sinclair refinery at Marcus Hook, Pa., installed a model 21-102 mass spectrometer for purposes of control analyses. An additional model 21-102 has been in operation at the new Research Laboratories at Harvey, Ill., since July, 1948; the East Chicago instrument remains in the service of that refinery.

At East Chicago, we normally operated on a 5-day, 3-shifts-per-day basis. Approximately 150 to 175 samples per week were analyzed on the 4-12 and 12-8 shifts; the 8-4 shift was devoted to research investigations and minor maintenance.

A complete log of all operating data was and is maintained as an aid in checking instrument condition. This data includes daily readings of ionization chamber temperature, ionization currents and voltages, pusher settings, galvanometer sensitivities, etc. Since routine operating conditions may be varied somewhat on the day shift, it is customary for certain settings to be checked again on the night shift.

It has been our standard practice to run known mixtures at least once every week as a test of overall instrument performance. On each operating shift an n-butane pattern is run in order to detect any significant changes in cracking patterns and sensitivities. A complete set of calibration data is normally obtained only once every three or four months; for certain mixtures results are more sensitive to small variations in instrument characteristics, and calibration data may be required more frequently with these samples.

In order to insure that calculation of analyses follows completion of sample runs as rapidly as possible, even during periods of maximum analytical demand, we have a separate well-integrated group in charge of all such calculations. This group also handles calculations for analysis submitted by the infrared and ultraviolet spectrometer personnel.

During full scale operation at East Chicago, a total of nine people were connected directly with the three-shift operation of the mass spectrometer. This group consisted of three operators, four computers, and two supervisors, for operations and calculations, respectively. This arrangement will probably remain in effect at Harvey.

The operators are not selected on the basis of previous technical training; they are, in general High School graduates and are classified as hourly employes. Several weeks of training are devoted to familiarizing them with operating procedures, laboratory practices, methods of handling various types of samples, and minor maintenance of the instrument. Actual operation, under the supervision of trained personnel, precedes assignment to shift work.

The computing personnel are non-technical, but have all had some college training. Some chemical background is highly desirable. They learn how to operate the calculating machines and how to handle the computations on the job.

The supervisory personnel consists of two chemists and a chemical engineer.

Theory and Operating Procedures

In the mass spectrometer, individual molecules and the various fragments thereof are sorted according to their relative masses and the numbers of particles of each mass are counted and recorded electrically. This process of sorting can be represented by the equation:

$$r = \left(\frac{2E}{B^2} \cdot \frac{m}{e} \right)^{1/2}$$

which states that under suitable conditions, if a particle of mass m carrying an electric charge e is accelerated by an electric potential E and is projected perpendicular to the lines of force of a homogeneous magnetic field of strength B, the particle will

assume a circular path in a plane perpendicular to the direction of the field and with a radius *r*.

It is seen that if positive ions are produced in a low-pressure gas by bombardment by low energy electrons, the ions, when accelerated by a high voltage, can be sorted into a number of *separate* circles, all tangent at the point of acceleration but with radii which vary with the mass over charge ratio. Since under the selected conditions, positive ions of unit charge are predominant, the masses of the particles control their radii. These ion beams are caused to fall in turn upon an ion-collector and the intensities are amplified and recorded.

Coincident with ionization, we get extensive fragmentation or cracking of polyatomic molecules into ions of lesser masses than those of the parent molecules. The cracking pattern for any compound is characteristic of its molecular structure and is reproducible under fixed instrument conditions. Therefore, quantitative analysis depends upon attainment of the following requirements:

1. The cracking pattern for each component is reproducible and independent of other substances present.
2. Ion intensities are proportional to partial pressure of parent molecule.
3. Linear superposition of ions from the separate constituents of the mixture occurs.
4. Isomers have sufficiently different cracking pattern to permit discrimination.

These conditions were moderately-well satisfied in the model 21-101 by manual control of the hot-filament electron source. In the currently produced model, 21-102, Consolidated has provided for a more sharply defined beam of electrons which is electronically monitored; changes in the ionizing electron current are automatically kept within one or two tenths of one per cent, a constancy which cannot be attained manually, irrespective of the degree of operator fatigue. The filament current is now more conveniently supplied by an electronic power supply instead of the large storage battery formerly used. Similarly, six "B" batteries which supplied amplifier plate and grid voltages have been replaced by another power supply. Another important added feature is tenth degree temperature control for the ionization chamber, which compensates for variations in room temperature as well as filament changes.

The value of these modifications which were made on the East Chicago instrument and are incorporated in the Harvey instrument is attested to by the reduction in daily pattern variations by a factor of two or three. Furthermore, the slow variation in cracking patterns which occurs over a period of weeks can be prevented by changing the ionization chamber temperature just enough to compensate.

Handling of Samples

Samples are received in a variety of types of containers, either in gas or liquid phase. The actual amount required for analysis is very small—about one microliter of liquid, or the equivalent of about 0.2 cc. of gas at atmospheric pressure. Most of our samples are received as gases in stopcock-ended glass bombs of about 150 cc. capacity and at pressures from 100 mm. to atmospheric. They are usually introduced to the glass inlet system of the mass spectrometer through a short length of flexible neoprene tubing.

Samples which must be taken at higher pressures are received in steel bombs of appropriate size. Such mixtures can be introduced either by the glass inlet system or by the metal system, which utilizes packless bellows valves. If heavy hydrocarbons (C_5 or higher) are present, use of the metal inlet system reduces the difficulties due to selective absorption in stopcock grease.

Liquid samples are transferred from their bottles by means of a taper ground thermometer tube or fine capillary pipette to a mercury sealed sintered glass valve of the type described by R. C. Taylor and W. S. Young[2].

Liquid calibration compounds are stored in glass containers which are provided with similar mercury-sealed sintered discs. Admission of such materials to the inlet system is accomplished by touching such a disc to a smaller one (immersed in mercury), sealed to the mass spectrometer inlet system; thereupon, vapors of the calibration compound pass through the sintered discs into the evacuated inlet system. An oil and mercury multiplying manometer is useful for measuring the pressure of low vapor pressure liquids.

After a sample has been introduced into the inlet system by one of these methods, it is expanded quantitatively to a pressure of about fifty microns and is then allowed to pass through a pressure-reducing leak system into the ionization chamber. The ionizing region is continuously pumped to maintain a pressure of 10^{-7} mm., which rises to about 10^{-5} mm. when a sample is passing through.

As the sample streams through the ionizing region, the ion accelerating voltage is caused to vary continuously; this causes the ion beam of each separate mass to strike the ion collector in turn. The signal received by the recording galvanometers thus appears along the mass scale as a straight line which is interrupted at intervals by sharp peaks in order of increasing mass number. An example of the type of record obtained appears in Fig. 2. This illustration first appeared in *Industrial & Engineering Chemistry, Anal. Ed.*, February, 1945.

The total time for running a single

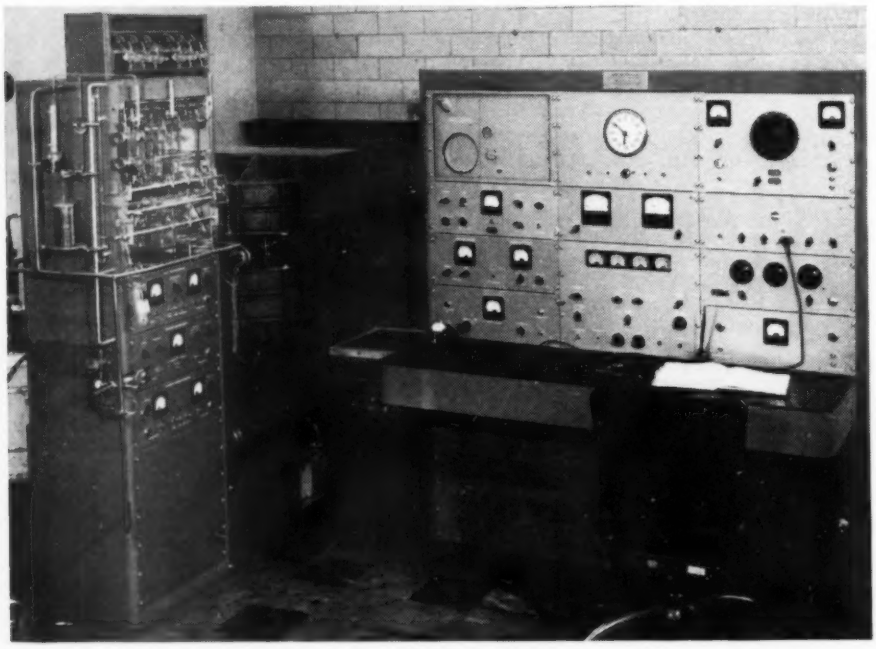

Fig. 1—Mass spectrometer installation at the Harvey, Ill., research laboratories of Sinclair Refining Co.

sample varies between fifteen and twenty minutes, including, in addition to actual running time, that required for pumping, actual introduction of sample, and developing of the photographic record which the instrument produces.

Methods of Calculation

In regard to calculation methods (3), the photographic record as obtained from the instrument is a permanent fingerprint of the particular mixture analyzed. The conversion of this record into percentage composition utilizes the extensive fragmentation which polyatomic molecules are undergoing. The fragments obtained are exactly those which would result from breaking every possible bond and combination of bonds, plus a small number resulting from isomerization and certain other processes which are not pertinent. The relative probability of each such process is fixed and reproducible for a given instrument under fixed conditions—this is what we mean by unvarying cracking patterns. It is apparent that two isomers such as n-butane and i-butane should yield almost identical ions, but the difference in molecular structure is great enough so that the relative amounts at each mass are quite different. The mass spectrometer can easily distinguish quantitatively between these two when both are present in the same mixture.

It can be seen that fragmentation of this type yields ions which contain one, two, three, etc., carbon atoms from parent molecules containing any greater number of carbon atoms. Thus, the butanes and butylenes will give many of the same ions as propane, propylene, ethane, ethylene, and methane in addition to the expected C_4 ions.

As a result of linear superposition of ions, the magnitude of the mixture peak M_i at a particular mass denoted by i is given by the equation

$$M_i = \sum_{j=1}^{n} a_{ij} C_j$$

where C_j is the magnitude of a certain base peak for the j'th component, a_{ij} is the pattern coefficient for the j'th component at the mass denoted by i. The base peak is selected separately for each component and frequently the mass corresponding to the parent molecule is most convenient. The ratio of total net galvanometer deflection per micron of pressure defines the sensitivity of any particular gas at the base peak. The pattern coefficient a_{ij} is the ratio of peak height at mass i to the peak height at the base peak times one hundred. A calibration run for each component in a mixture is necessary for the calculation of the pattern co-efficients and sensitivity of that component.

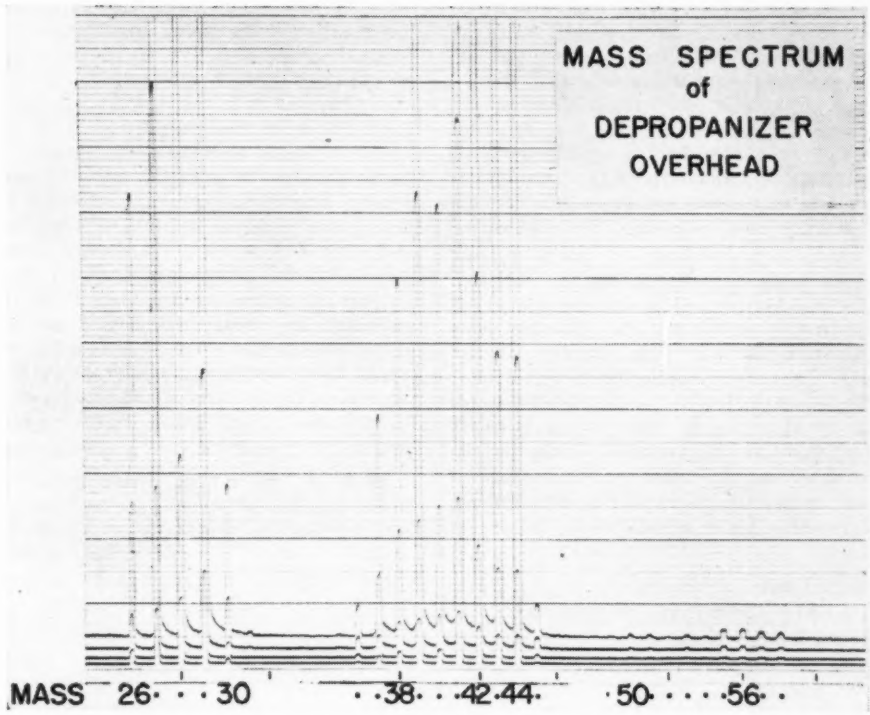

Fig. 2—Example of a typical hydrocarbon mixture, the mass spectrum of depropanizer overhead stream, as recorded by the mass spectrometer. (Photo courtesy Industrial & Engineering Chemistry, Analytical Edition)

In general, if there are n components in a mixture, one must have n equations to obtain a solution, and n suitably chosen mixture peaks must be selected from the spectrum of the sample. Fortunately, this general method needs to be applied in but few analyses and a simplified step-by-step method of calculation can be used. One or more components can usually be determined directly from peaks which are unicomponent in nature. Since the cracking patterns of the compounds are known, it then is possible to correct the mixture spectrum for contributions of those components at all masses. This may leave some new unicomponent peaks and the process is repeated until all components have been determined in turn, or until the number of simultaneous equations requiring solution has been reduced to a minimum.

As examples, consider three mixtures:

1. Methane, ethane, ethylene, propane and propylene.
2. Methane, ethane, propane, propylene, n-butane, i-butane, 1-butene, 2-butene, and i-butylene.
3. 1-Pentene, 2-pentene, 2-methyl-1-butene, 3-methyl-1-butene, and 2-methyl-2-butene.

The first of these mixtures may be calculated without the use of any simultaneous equations; the second requires a set of two equations for the separation of n-butane and i-butane and a set of three equations to split the butylenes; the third mixture demands solution of a set of five simultaneous equations.

Using an ordinary electric calculating machine, the total elapsed calculation time for the average mixture of ten components may amount to one hour. In our department we use electric calculating machines and an electro-computer designed by Consolidated Engineering Corporation specifically for the job of solving linear simultaneous equations. The elapsed calculation time is thereby reduced to approximately twenty minutes for the same type of mixture. An additional twenty to thirty minutes is required for setting in calibration data, but this need be changed only when the mass spectrometer is recalibrated.

A combination of plant control and research department samples presents a wide variety of mixtures. It has thus been found desirable for the supervisor of calculations to be familiar with the general nature of the processes from which samples are obtained. He can then more readily interpret unusual features of samples and notice immediately significant changes in plant operations.

The mass spectrometer is an exceptionally powerful tool for the

rapid analysis of many types of mixtures produced in normal refinery operation. With this instrument it is possible to analyze certain complex mixtures containing twenty or more components. As far as the mass spectrometer is concerned, a mixture of this complexity is analyzed by the same method as a mixture of n-butane and i-butane, for example.

As the operations of many refineries have been expanded to include the production of a wide variety of synthetic chemicals, the use and application of the mass spectrometer has increased accordingly. The instrument will analyze for many classes of compounds other than hydrocarbons. As examples of other types of analyses we may cite miscellaneous mixtures of alcohols, aldehydes, ketones, ethers, mercaptans, etc.

The limitations upon complexity of mixtures are fixed by:

1. Availability of calibration compounds.
2. Computation time.
3. Mass resolving power of the instrument.
4. Similarities in cracking patterns.

It would be futile, for example, to introduce certain types of mixtures without prior fractionation into cuts of reasonably narrow boiling ranges.

The extension into analyses of hydrocarbon mixtures of higher molecular weight and into the non-hydrocarbon field has been largely initiated and forwarded by the group at the Atlantic Refining Co.(4) and the research personnel of the Consolidated Engineering Corp.

As examples of the types of mixtures which have been handled in the Sinclair laboratories, we mention:

1. Refinery streams, C_1 through C_5.
2. Pilot plant samples, C_1 through C_7.
3. Mixtures of C_6's.
4. Miscellaneous aromatics.
5. Sulfur containing compounds.
6. Flue gases.
7. Special samples from adsorption studies.
8. Liquid nitrile mixtures.
9. Gaseous mixtures of nitriles, hydrocarbons, and non-condensables.

A sufficient number of pure calibration compounds must be maintained for the range of analyses. Hydrocarbons of extremely high purity are available from the National Bureau of Standards and A.P.I. Project No. 46. Other materials are synthesized and purified or obtained commercially if the purity is known to be high.

For an analytical method to be suitable for control of refinery operations, it should be reproducible, accurate, and rapid. The mass spectrometer possesses all of these qualities to a high degree. It seems to be the most generally useful all-around instrument for such control work and the high initial cost is rapidly paid off by the low cost per analysis where a large number of samples are encountered. The average elapsed time of 1½ hours is to be compared with the 6-8 hours required by some older methods. In certain specialized, but important cases, useful results can be reported in twenty minutes after receipt of sample. The availability of such an instrument permits plant processes to be carried out with a certainty and an efficiency that was not previously possible.

It is not meant to imply that the mass spectrometer will do everything. Absorption spectroscopy, of course, is another field of wide possibilities, and many types of mixtures are handled by such instruments which cannot be analyzed by the mass spectrometer.

Research Applications

The mass spectrometer is not limited to analytical applications alone. Valuable information about bond energies can be obtained from the appearance potentials of suitable ions. The appearance potential is essentially the minimum electron energy required for the appearance of a given fragment. With certain other information it can be used to calculate an upper limit for the energy of a particular bond. Possible application to studies of various types of cracking processes awaits further study and more abundant data.

Nothing has been said of the fact that some of the peaks in the mass spectrum result from the presence of isotopes in the molecules. The mass spectrometer can determine such isotopes quantitatively and is, therefore, valuable in the study of reaction mechanisms when stable (non-radioactive) isotopes are used. Best results are obtained, however, when a mass spectrometer which is designed for that purpose is used. Such an instrument has been adapted from the design of A. O. Nier(5), and is now available commercially from Consolidated.

Instrument Maintenance

The mass spectrometer, in common with other electronic instruments, demands a certain amount of maintenance. Although many refineries have the services of personnel skilled in electronic instrumentation such qualifications are not essential for servicing of the mass spectrometer. In the majority of laboratories, it is accepted practice for the personnel directly in charge, e.g., chemists, chemical engineers, physicists, to handle repairs.

At the time of the initial installation, the manufacturer provides a personnel training program. During this period a presentation is made of all electrical circuits, together with mode of operation, application in the instrument, and problems of maintenance. This procedure simplifies later questions which may arise in regard to trouble shooting.

In those groups where the emphasis is placed upon the accomplishment of many routine analyses, it is probably advantageous to adopt a regular servicing schedule rather than to interrupt analytical periods for minor adjustments or replacements. Sustained three shift operation results in wear of certain parts. For example, the high vacuum stopcocks used for admission of samples are lubricated with a grease that becomes fatigued with constant use. In addition, the "background" of the instrument may become excessive after a large number of mixtures of high molecular weight have been analyzed. It has been our practice to fix two weeks of continuous operation as the maximum permissible period. At that time, on the day shift, the instrument is brought down. The schedule of overhaul includes complete regreasing of stopcocks, inspection of vacuum pumps and pump oil, replacement of any minor items scheduled for installation, and a "bakeout" after the vacuum has been re-established. This overhaul requires less than eight hours and operation is resumed on the same or following shift.

It is apparent that all other repairs are not eliminated by this regular servicing period. Replacement of ionization chamber, which is required at rare intervals, will necessitate a loss of several days operation time. The old unit must be removed, the spare one installed, a sufficiently good vacuum be attained, performance characteristics of the new ionization chamber be studied, and calibration data be made available, before operation is resumed.

Over a long period of time, it may be said that approximately one shift per two weeks of continuous operation is required for maintenance other than the regularly scheduled period. The Consolidated Engineering Corp. has instituted a program of consultation and service which is available to users of their mass spectrometer. It is thus possible to obtain expert personnel for the solution of unusually difficult problems.

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SIX CASE HISTORIES

How to Increase Propane Recovery

By D. P. THORNTON, Jr.
Southwestern Editor

TWO years ago the rapidly increasing demand for propane began to stimulate natural gasoline plant operators to augment their recovery of this once-ignored light hydrocarbon. For the most part operators at that time were interested in revamping existing facilities to raise recovery rates, rather than in installing new plant capacity.

The procedures and processing techniques then advanced[1] for securing this increased propane retention included:

1) Increasing oil circulation.
2) Refrigerating the wet gas or the absorber oil, or both.
3) Raising absorber operating pressure.
4) Reabsorbing residue gas from existing absorbers.
5) Stage flashing and recompressing.
6) Adding new and/or larger de-ethanizers.
7) Increasing capacity for other parts of fractionating facilities.
8) Eliminating operating bottlenecks wherever possible.

What has been the experience of natural gasoline plant operators since then? How much have propane yields actually risen? What processing methods have been adopted? What changes in equipment have been made? To find the answers to these and other questions, PETROLEUM PROCESSING recently completed a study of the present actual operations in the six selected plants, representing five natural gasoline manufacturers in the Southwest. Briefly, this survey showed that:

1) Existing plants have been revised successfully to produce propane at recovery rates as high as 85%. One plant moved up from 10% to 70% recovery, another from 53% to 75%.

2) One entirely new plant, recently completed, is now producing propane at a 90% rate.

3) Processing techniques adopted for the most part include those proposed two years ago.

The present article describes in detail what the six plants surveyed have actually done to augment propane recovery. In considering what these plants have found feasible, it must be borne in mind that each remains a law unto itself—what was best for one might have been worse than useless for another. Interesting also are various ways of applying what might be termed "standard methods."

Further, economic factors have played an important part in the engineering decisions made. One plant, for example, has a "rich" gas which lends itself to a recovery technique not advisable for a plant charging a "lean" gas. In others, advantage has been taken of a market for residue gas or development of a repressuring project to help pay the bill for increasing propane retention. In still others, plant location with respect to potential markets has resulted in the decision to use a propane recovery efficiency considerably below what otherwise might be practical from an engineering standpoint alone.

Enlarging on this latter point somewhat, it was found in gathering material for this article that some natural gasoline plant operators have admittedly been conservative in going after additional propane because they feared the possibility of winding up with more propane producing capacity than their particular market could absorb. Others point to the fact that propane prices now have declined somewhat from 1948 highs as indicative of a possible leveling off in the heretofore steadily rising demand curve and perhaps also as a signal that supply is beginning to catch up. Several, in adding facilities to increase propane extraction, have done so in such a manner that this equipment can be either operated or shut down without affecting the rest of the plant.

1 WARREN PETROLEUM CORP.
Holliday, Texas
Previous Recovery—65%
Today's Recovery—85%

TYPICAL example of the face-lifting which several of Warren Petroleum Corp.'s natural gasoline plants have undergone for higher propane recovery is the Holliday, Texas, plant. In nearly every case, the evolution of a repressuring project or sale of residue gas to a pipeline, or both, have made feasible an increase in absorption pressure, installation of a de-ethanizer or a "de-methanizer," at this company's plants. Generally it has not been necessary to increase absorption oil circulation.

As originally designed, the Holliday plant was distinguished particularly for the extensive use of air-cooled exchangers in most of the cooling requirements, lean oil as process heating medium and no steam generating facilities, all necessitated by the lack of a satisfactory water supply.[2] The plant made propane, but approximately 35% of theoretical was lost overhead in the de-ethanizing absorber.

Later in 1947 the demand for propane was considered sufficient to warrant capturing an additional quantity of propane. A de-ethanizer and related equipment operating on depropanizer overhead was installed. By the next year additional requirements for repressuring in the Hull-Silk and Daume-East Holliday pools were evident; the demand for propane still was strong. This made feasible the installation of facilities for boosting absorption pressure from the original 200 psi. to 800 psi., together with a new absorber to retain 90% of the theoretical propane content of the raw wet gas. For simplicity, these two separate process revisions, increasing propane recovery to the 85% mark, will be treated as one.

Since the plant originally absorbed at 200 psi., a third-stage compressor, scrubber, etc. were installed, taking suction off the second-stage scrubber. Formerly, compressed gas at this point was charged to the de-ethanizing absorber. The compressed gas now feeds two activated alumina dehydrators, as shown in the flowsheet, Fig. 1. One of these operates on liquid condensate from the last compression, the dry liquid now going to the fat oil de-methanizer (formerly the de-ethanizing absorber). Dry gas

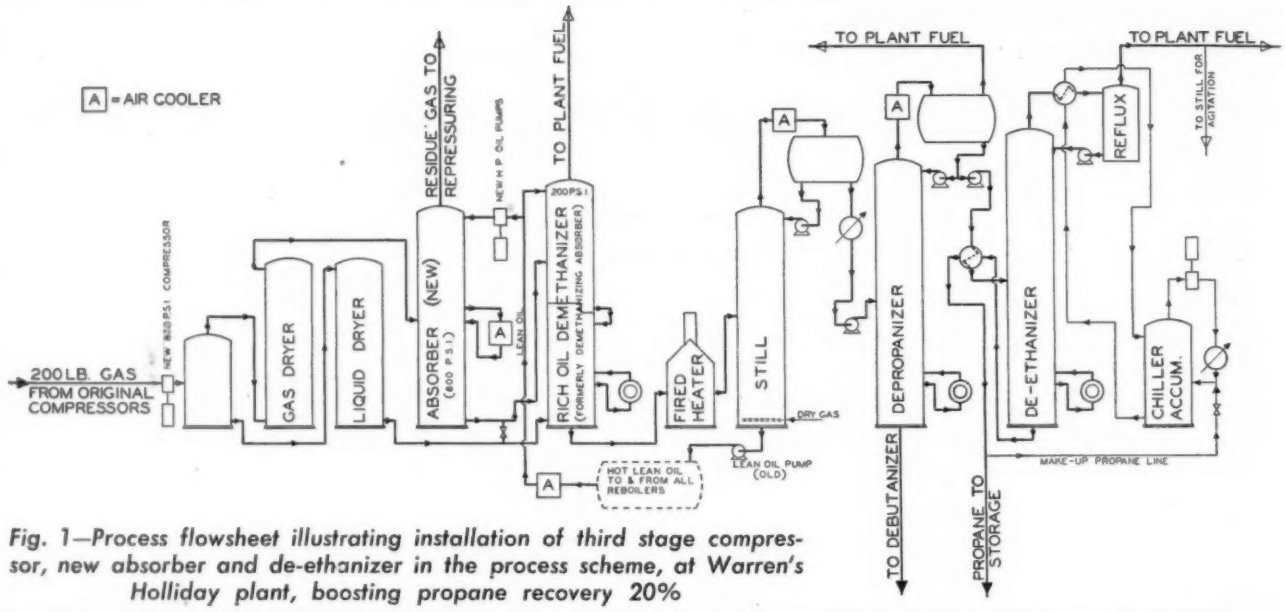


Fig. 1—Process flowsheet illustrating installation of third stage compressor, new absorber and de-ethanizer in the process scheme, at Warren's Holliday plant, boosting propane recovery 20%

from the other enters the new 800-psi. absorber. One stage of oil intercooling (by water) is used in this column.

Dry gas from the absorber residue scrubber splits into two principal 800 psi. streams. The largest portion is used for repressuring the Hull-Silk pool. The remainder, after furnishing plant fuel gas needs, goes to the original booster compressor supplying 1800-2000 psi. gas for repressuring the Daume-East Holliday pool.

Lean oil for the new absorber is taken as a side-stream from the line feeding the top of the rich oil demethanizer. Upon leaving the new absorber it returns to the upper half of the de-methanizer. The original lean oil charge pump (now called the low-pressure lean oil pump) was entirely inadequate to furnish the higher pressure. The new high-pressure pump consists of two paralleled Cooper-Bessemer "Twin-Line" two-throw, four-cylinder, liquid pumps, driven by a twin-cylinder two-cycle horizontal gas engine. This is said to be the first gasoline plant application of these compact, late-design pumps.

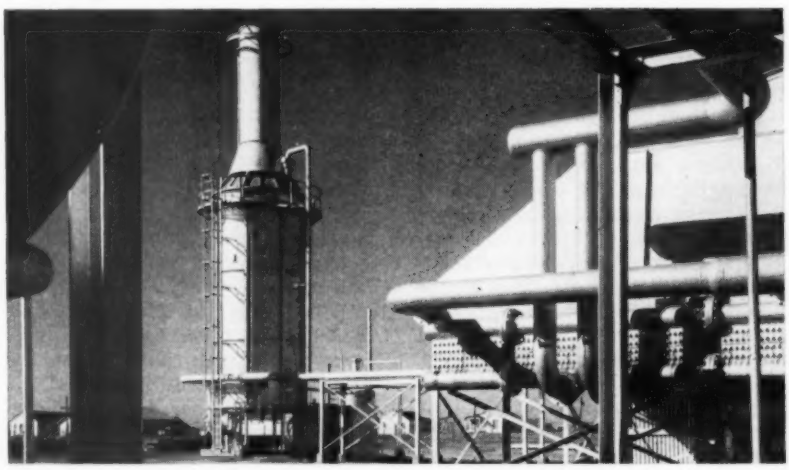
De-methanized rich oil from the fat oil de-methanizer is heated and stripped of hydrocarbons in a fired still. The hydrocarbons are then depropanized in the conventional manner; bottoms entering the debutanizer as in the original design. Depropanizer overhead vapor, however, instead of containing only propane as is the usual case, has some 90% of the propane originally in the wet gas plus approximately 5% of the ethane. (All the methane and 95% of the ethane in the rich oil is taken overhead to plant fuel in the fat oil de-methanizer.) At this point the new de-ethanizer has been inserted, charging the excess of depropanizer overhead not needed for reflux.

This charge stock is too cool for good fractionation and therefore is preheated in a double pipe exchanger against de-ethanizer bottoms. Reflux to the de-ethanizer is substantially ethane, refrigerated with propane to maintain a tower top temperature of 71° F. Excess overhead not required for reflux is piped into the dry gas system; a small sidestream is returned to the still for agitation purposes. Not more than 3% of the initially-absorbed propane is lost to dry gas.

The refrigeration system derives its make-up supply from propane going to storage. Liquid propane from the chiller-propane accumulator is expanded in the de-ethanizer reflux chiller and returns to this drum. The compressor takes suction on drum vapors, returning them after cooling in atmospheric sections in the cooling tower as a liquid. In cold weather, or in the event of refrigeration compressor failure, de-ethanizer overhead may be cooled by the atmospheric sections ordinarily used to condense refrigeration propane vapors. This alternative arrangement has been omitted from the process flowsheet (Fig. 1), for simplicity.

By this arrangement considerable flexibility has been built into the plant. Since the high-pressure end and the de-ethanizer were added

This Month's Cover Picture



Tubular fired oil heater at Warren's Holliday plant, where propane recovery has been increased from 65% to 85%. This heater handles all the rich oil and, after absorbed natural gasoline is removed in the still, supplies all the reboiler heat required in the plant plus that needed for buildings. Beside it is the oil purifier, and at the left a portion of an air-cooled heat exchanger

after the original plant was built they are, so to speak, in reality "side-stream" arrangements, to be by-passed at will. Consequently, should the plant not be able to dispose of all the propane it is capable of producing at some future date, there is no point in separating all this propane.

With the plant piped up as it is, the new de-ethanizer can be shut down with the new absorber. The fat-oil de-methanizer then would be returned to its former service as a de-ethanizing absorber and the third-stage compressors operated on residue gas. In this manner no gas is wasted from the plant under either operation.

From a plant making 85% propane it would revert to a 65% propane producer. This will not interfere with the operation of the repressuring projects. Likewise, the arrangement is of value during plant maintenance. Except when the oil heater and still or fractionator battery need attention, only a part of it need be shut down at any one time. The oil system already is protected by continuous oil purification.

Equipment used is more extensive than in some of the other plants described in this article. A new absorber, a high-pressure compressor, two high-pressure lean oil pumps, additional heat exchangers and coolers, new de-ethanizer and related equipment, refrigeration facilities and storage tanks were required, plus instrumentation.

SKELLY OIL CO.

2 Kingsmill (Pampa), Texas
Previous Recovery--20-30%
Today's Recovery--50-55%

THE Kingsmill plant (near Pampa, Texas) of Skelly Oil Co. has been revamped primarily as a result of repressuring operation in the nearby area. Propane recovery increases therefore are incidental, but real, even though the plant is not a high propane producer in the usual sense with an extraction efficiency of 70 to 80% or higher.

Kingsmill also is somewhat unusual because it has no fractionating equipment. It strips absorption oil and pumps the resultant liquid to Skelly's Schafer plant nearby, where this material, along with similar output from the nearby Crawford and Watkins plants, is combined and fractionated into propane, butanes, and stabilized natural gasolines of controlled vapor pressure.

Kingsmill takes low-pressure oil well gas and compresses it to 500 psi. before absorbing. Formerly, absorption pressure was 45-50 psi. and the excess residue gas was sold for carbon black manufacture. The Schafer, Watkins and Crawford plants still operate in this manner.

Absorption oil at Kingsmill enters the absorber at 85° F. at the rate of 200 gpm. from atmospheric sections in the cooling tower. Oil is taken off at three points down the tower, passed through shell-and-tube exchangers, and chilled with propane to stage intercool to 65° F. Sufficient refrigeration is maintained to hold absorber bottom temperature to approximately 75° F. By this arrangement advantage is taken of the favorable absorption temperature factor for ethane and lighter at 85° F. and above, preventing absorption of as much of this material as normally would be expected if lean oil entered the absorber at a temperature like the 65° F. maintained on the intercooler exit oil.

Oil leaving the absorber is flashed in a reabsorber at 90 psi., the combined oil streams then entering a steam preheater and ultimately the still. Still bottoms are steam stripped. The overhead is condensed, freed of water, and pumped to the Schafer plant for de-ethanizing and fractionation into LPG and natural gasoline. This processing sequence is conventional, except that capacity is sufficient to handle raw gasoline production from the absorber batteries of all plants involved.

At the present time approximately 50 to 55% of the theoretical propane content of the wet gas processed at Kingsmill is recovered in Schafer's stock tanks. The other plants have propane extractions in the 20 to 30% bracket. Currently in the design stages is a revamp of Schafer's absorption section. This will provide for a higher propane recovery there and likewise make available more gas for pressure maintenance purposes in the area.

New equipment required at Kingsmill included a new high-pressure aborber, the required additional compressors, new high pressure lean oil pump and associated auxiliaries.

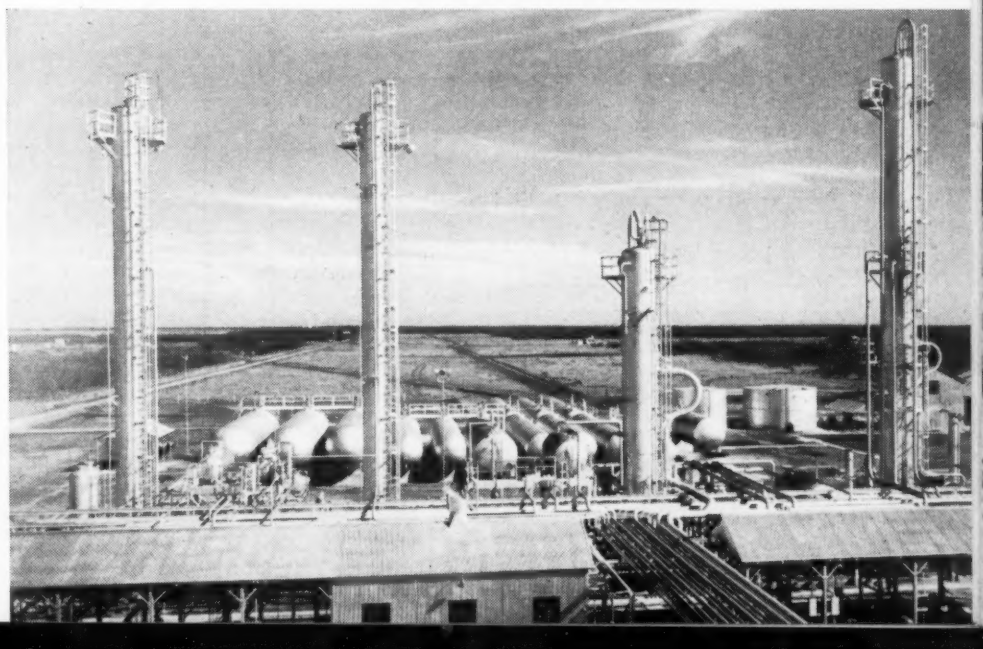
GREGG-TEX GASOLINE CORP.

3 Longview, Texas
Previous Recovery—10%
Today's Recovery—70%

THE Longview, Texas, plant of Gregg-Tex Gasoline Corp. originally was constructed to recover only stabilized natural gasoline; therefore 95% butane and only incidental propane, which amounted roughly to 10% of that in the wet gas. Through the years it has been successively revamped until at the present time it recovers approximately 70% propane and substantially 100% of the heavier constituents. It is unusual among plants having high propane extractions because it does not depend on absorption except for the final 10% of its propane recovery. In part the unusual design is possible because of the richness of the raw gas.

When the plant was first built, raw field gas was compressed to 250 psi., cooled and charged to a "recovery" tower, the fluid being partly liquid and consisting of all interstage condensate plus compressed wet gas and final stage condensate. The recovery tower acted also as a de-

General view of Warren's Holliday plant. Towers, from left to right, are absorber, still, depropanizer and debutanizer, with gasoline, butane and propane storage tanks in background. Pumps on left side of pumphouse supply the towers; oil pumps are on right. Buildings at right background are water treater (beside the large water tanks) and warehouse



ethanizer, utilizing water-cooling for reflux requirements, discharging "dry" gas overhead and "wild" gasoline to a stabilizer. This overhead was totally condensed, and returned to the recovery tower as additional reflux as well as furnishing all reflux requirements for the stabilizer. Bottoms were stabilized gasoline and the only liquid product, as shown in Fig. 2. The only reason stabilizer overhead could be totally condensed with water cooling was because the recovery tower acted also as a de-ethanizer.

A few years later, when butane became salable, and also more gas was available for the plant, capacity was increased by installing another recovery tower, adding a single, larger stabilizer. This idled the old stabilizer. An exchanger was installed ahead of the recovery towers to chill the compressed wet gas to 60° F, with propane as refrigerant. Cooling water in the recovery tower reflux condenser also was replaced with propane to chill the overhead gas ot 45° F. A lower temperature was not permissible so as to avoid hydrate formation. Overhead from the stabilizer was not returned to the recovery tower, but went to LP-gas storage; recovery generally exceeded 95% butanes.

The third face-lifting saw the plant equipped to recover approximately 60% or about 3.75 gpm. of the theoretical propane in the wet gas through the addition of a depropanizer and more refrigeration capacity. Incoming wet gas to the recovery tower now was cooled to 45° F., hydrate formation being prevented by injection of enough diethylene glycol to absorb condensed water (and separating the glycol-water mixture ahead of the tower). Similarly, the top of the recovery tower was cooled by chilling the reflux to 0° F. with propane (more refrigeration capacity was added at this time) to promote propane retention. Hydrate formation at this point likewise was prevented by diethylene glycol injection. Recovery tower bottoms were successively depropanized and debutanized.

Recovery tower bottoms were settled to recover injected glycol. Glycol settlings from the incoming gas stream and recovery tower bottoms were combined for reinjection, with a small slip-stream being taken continuously to a heater for dehydration.

Up to this point it will be noted there were no absorption facilities in this plant. All products were recovered initially—and the majority still are, incidentally — by fractionation only. Unwanted hydrocarbons likewise have been separated from desirables in this manner. Moreover, in increasing recovery efficiencies from time to time, temperatures of feed and reflux leaving the condenser have been successively lowered.

In the plant as first constructed it was vital to return stabilizer overhead to the recovery tower as additional reflux, not for the additional volume of liquid, but because this material contained low boiling, undesirable but condensible hydrocarbons which were to be eliminated from the system (to dry gas). By re-evaporating these light ends in the recovery tower, the desired heavier hydrocarbons were condensed, and thus retained in the tower. Otherwise, they would have migrated into the reflux condenser until dew-point conditions were satisfied and thus become lost from the system.

During the "second" stage of revamping for higher propane recovery, refrigeration chilled the reflux to the recovery tower sufficiently to retain most of the propane on the upper trays of the recovery tower. The reflux then was—and is yet—largely ethane contaminated with propane. Function of the former stabilizer now has been taken over by the combined action of depropanizer and debutanizer; this combined overhead is not needed now as reflux at the recovery tower and indeed contains no ethane; hence its return to the recovery tower would be a detriment.

Theoretically at least, an extension of the recovery tower scheme would have sufficed for still higher propane recovery by further reducing the temperature of the top trays of the recovery tower, and further chilling the feed to the recovery tower. The latest modification, to gain approximately 10% additional propane recovery via the absorption route, was designed and installed by Gregg-Tex engineers. The previous designs were the work of outside consultants.

It was known that about 40% of the theoretical propane content of the raw gas was going overhead with the residue gas leaving the recovery tower. It was decided to retain some of this by the absorber route, using a 150-160 molecular weight distillate as the oil. An unused tower, 30 in. by 40 ft., was available. It was filled with Raschig rings and used as the still. One 36 in. by 50 ft. absorber was purchased. It was necessary also to purchase a fired heater, seven exchangers, two centrifugal and one reciprocating pumps, plus the required instrumentation. Balance of the equipment was available from unused items acquired earlier for other purposes.

These were combined as shown in the present plant flowsheet, Fig. 3, so that the absorber was fed with 250 psi. overhead vapor from the recovery tower. The absorber operates at 230 psi. with oil entering at 90° F. Dry gas is routed to the previously existing plant residue system. An interesting point here is that the absorption system can be by-passed

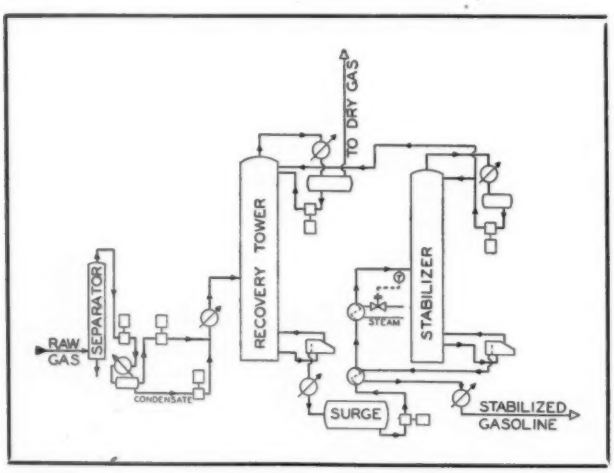


Fig. 2—Gregg-Tex plant processing scheme as first installed. Note absence of absorption facilities and return of part of stabilizer overhead to "recovery tower"

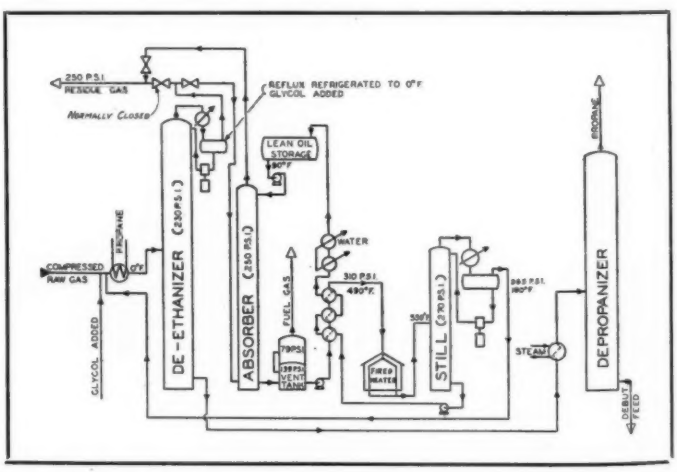
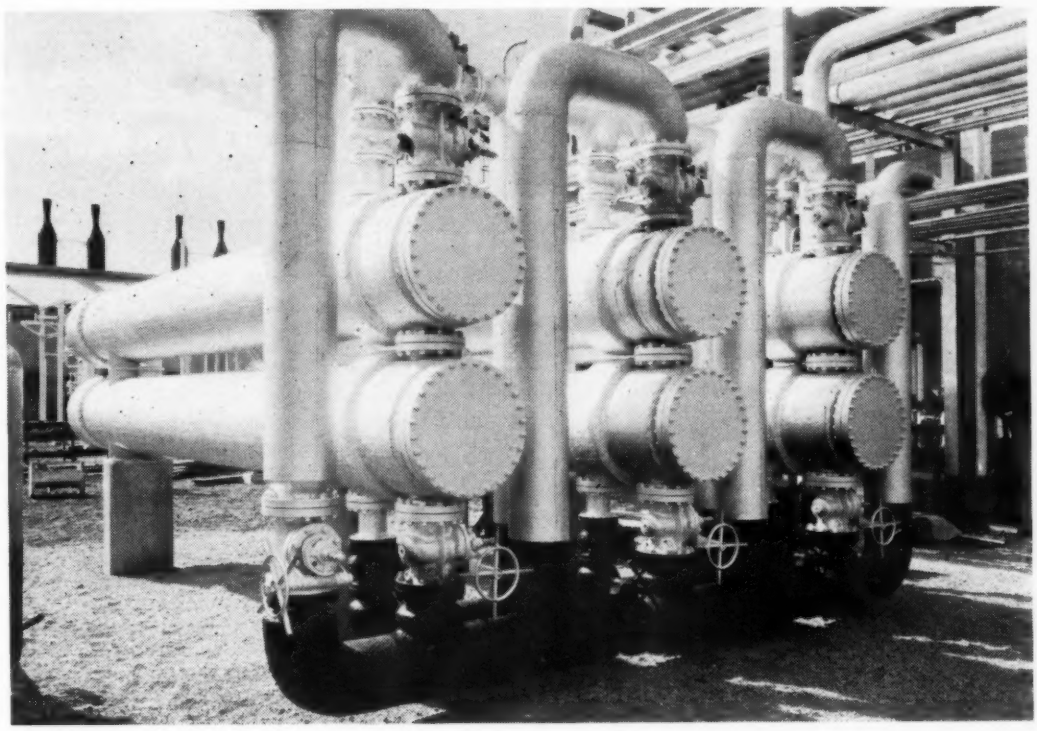


Fig. 3—Schematic flowsheet of processing sequence at Gregg-Tex as it is today. Note absorber circuit is independent of balance of plant as it was after several revampings



Lean-to-rich oil exchangers at Shell's Sheridan plant give an idea of the massiveness of equipment required. Note liberal use of metal jacketing around pipe insulation, and large plug valves

at will without affecting operations elsewhere in the plant. Fat oil exchanges with stripped lean oil, enters the fired heater at 490° F. and leaves at 550° F, is stripped at 270 psi. in the still. Still overhead, partially condensed, enters the recovery tower or de-ethanizer feed at 265 psi. A considerable vapor load is diverted from the still by flashing the absorber oil at 139 psi. and venting the vapors from the top section of the partitioned vent tank at 79 psi. to heater fuel and plant residue systems. A pressure of 90 psi. is maintained on lean oil storage by a pad line from the 250 psi. residue gas system.

Present gas throughput of the plant is 10,000 Mcf. daily, dictated by current field allowable. Total capacity rating is 16,000 Mcf. per day. Propane production now averages 45,000 gal. daily, including the gain from the latest 10% increase in propane recovery.

SHELL OIL CO.

4 Sheridan, Texas
Previous Recovery—53%
Today's Recovery—75%

SHELL Oil Co. has used two entirely different approaches to the common problem of increasing propane recovery at its Sheridan (Texas) and Magnolia (Arkansas) plants. Differences in approach are explainable in part by the fact that Sheridan is a cycling plant while Magnolia is a natural gasoline plant. Also, the engineering factors and other considerations involved were entirely different.

The gas throughput at Sheridan was 80,000 Mcf. per day. Some 53% of the propane in the raw gas was being recovered in the stock tanks. On an analytical basis, there was one gallon of propane per Mcf. in the gas and, on basis of gas throughput, there was 1900 b/d of propane in the inlet gas. Approximately 700 b/d of this propane was being lost in the de-ethanizer overhead, along with methane and ethane. From economic studies it was decided to increase overall propane recovery by 400 b/d which, on the basis of 80,000 Mcf. of inlet gas would mean a recovery of approximately 75% of the inlet propane.

The de-ethanizer net overhead vapor contained approximately 28% by volume of propane. A rectified absorber operating at 400 psi. was decided upon to recapture the "lost" C_3 from the 4000 Mcf. of gas involved, using an oil circulation rate of 70 gpm. This was to operate by presaturating a sidestream of lean absorption oil with "dry" gas as it entered the top of the column, a proportionate amount of the undesired hydrocarbons being desorbed as the propane was recoverd. Reboiling the bottoms by exchange with steam would give the necessary stripping action. The rich oil bottoms then would be returned to the lean oil stream at the main absorber.

In terms of plant equipment, this meant converting the plant's existing de-ethanizer to a rectified absorber and installing a new and larger de-ethanizer with associated exchangers, pump, and reboiler. Two additional 1500 bbl. propane storage tanks also were required. The additional oil circulation of 70 gpm. did not require new pumps or additional oil coolers.

SHELL OIL CO.

5 Magnolia, Arkansas
Previous Recovery—15%
Today's Recovery—30%

MAGNOLIA already had been enlarged once by paralleing exchangers and installing larger impellers in the absorber oil pumps to permit increased oil circulation. After these extensions, the oil circulation capacity of 350 gpm. represented the maximum for the installed equipment and the top gas capacity was 20,000 Mcf. The throughput later dropped to about 15,000 Mcf. as a result of decreased field gas production.

Propane recovery was only incidental, amounting to 15%, or about 120 b/d. The recovered material was divided between the excess butane remaining after stabilizing natural gasoline to desired vapor pressure (LP-Gas production) and propane product amounting to 1500 gal. per day produced from a small de-ethanizer operating on depropanizer excess reflux. Meanwhile, an additional 8000 Mcf. of wet gas was made available to the plant from the near-

by Village Field, where a booster station was installed.

Designers decided to increase simultaneously Magnolia's propane recovery and boost gas throughput capacity of the absorbers to 23,000 Mcf. daily. Absorption oil refrigeration was preferable to increasing the oil circulation rate, since maximum oil circulation capacity had been reached in existing bubble columns during the first revamping.

Two low stage compressor cylinders, originally installed to compress field gas to 60 psig., were available under the new processing scheme by reason of reduced Magnolia Field gas volume. It was decided to use them for refrigeration service, operating on butane as refrigerant since the allowable maximum working pressure was only 65 psig. The resultant refrigeration amounts to approximately 200 tons per day, cooling 350 gpm. of lean oil to 60° F. Intake gas is not refrigerated.

A de-ethanizer and related facilities were installed to de-ethanize all raw gasoline production, thus eliminating the requirement for the original small de-ethanizer operating on excess depropanizer reflux.

After the addition of the refrigeration system and de-ethanizer, the propane recovery, based on 23,000 Mcf. gas throughput, increased to 30%. The plant is now producing approximately 8000 gal. per day of commercial propane, with a balance of 7000 gal. per day being combined with excess butane to produce a propane-butane mixture.

TEXAS NATURAL GASOLINE CORP. (New Plant)

6 Abilene, Texas (Wimberly Pool) Today's Recovery—90%

THE Wimberly Pool plant of Texas Natural Gasoline Corp. near Abilene, Texas, is an example of the modern trend in the absorption type of all-new natural gasoline plant construction, featuring high propane recoveries and special preparation of residue gas for industrial and domestic utilization. It has been completed but a short time, has an ultimate gas throughput capacity of 8000 Mcf. per day and produces propane, propane-butane mixtures and stabilized natural gasolines ranging from 14 to 26 Rvp.

Sour, raw gas is received at the plant separator at 5 in. Hg. vacuum, for compression to absorber operating pressure of 250 psi. The absorber is of conventional design for high propane extraction, having 26 trays with provision for intercooling the oil to remove a part of the heat of absorption. Oil flows from the absorber to a rich oil de-ethanizer, which operates at 210 psi., where a large per cent of the absorbed methane and ethane is removed. A schematic diagram of this processing sequence is shown in Fig. 4.

It will be noted that dry gas overhead from the absorber is returned, in what is now becoming a more common practice, to the base of this column. Here it is scrubbed before leaving the plant as residue gas. Reason for the arrangement is savings in fabrication and installation. A side-stream from the residue gas is used as fuel for compressor drivers.

Dry gas from the absorber eventually will be processed through a Girbotol unit for hydrogen sulfide control. The excess over that used as compressor fuel ultimately will be compressed to 450 psig. for delivery gas pipeline. Oil de-ethanizer overhead, still more sour, is used as fuel for the fired tubular oil heater.

The still operates at 95 psig. Overhead is partially condensed in an air-cooled primary exchanger, backed up by a water-cooled final condenser discharging into an accumulator. Noncondensible vapors at this point are recompressed to 220 psi., water-cooled to total condensation. Liquid condensate from the still final condenser is pumped to the recompressor discharge, immediately ahead of the recompressor condensers. The total product, after being accumulated in a surge drum, is pumped through solid desiccant dehydrators to the de-ethanizer.

Aproximately 11,000 to 12,000 gal. of excess propane over that utilized in propane-butane mixtures is produced. This represents 90% of the propane theoretically in the raw gas. Ultimately additional compressors will be installed to handle another million cubic feet of gas

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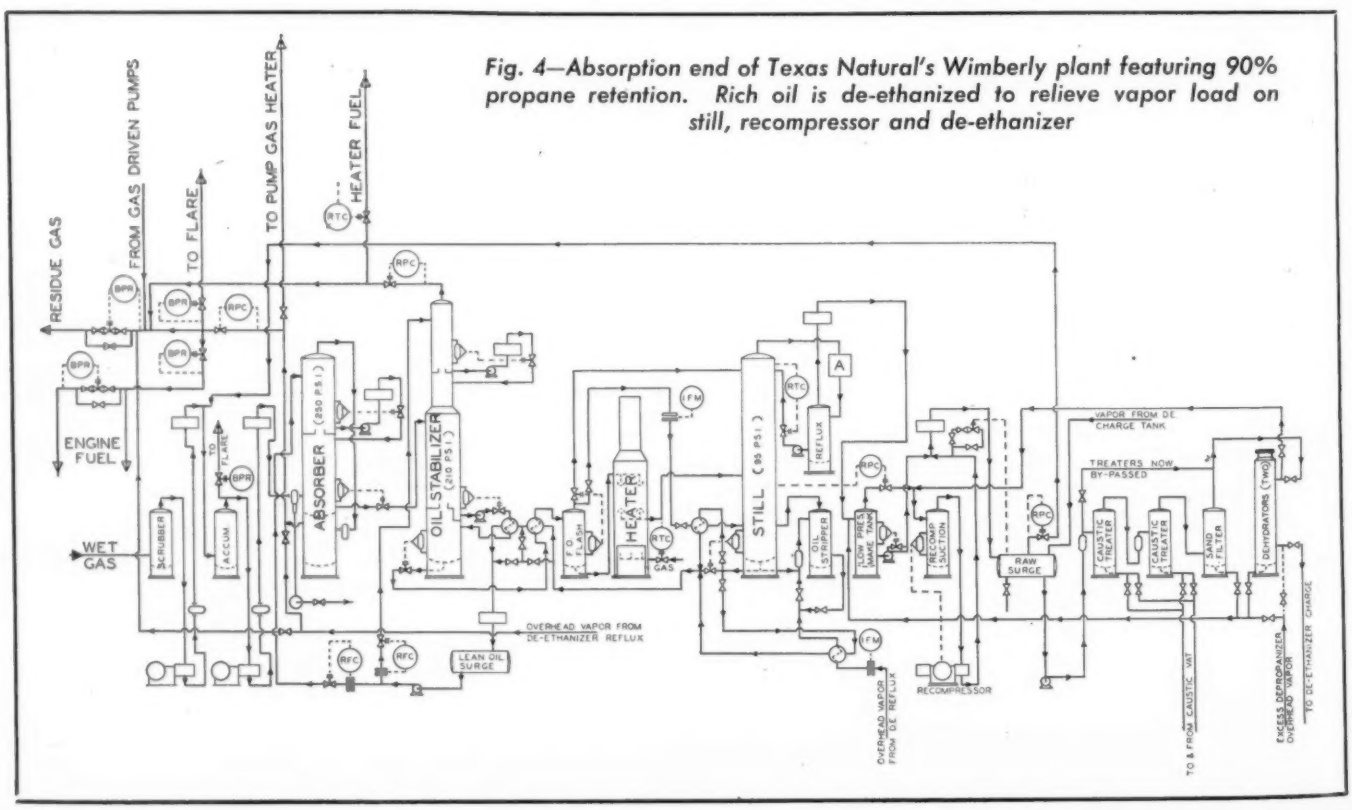

Fig. 4—Absorption end of Texas Natural's Wimberly plant featuring 90% propane retention. Rich oil is de-ethanized to relieve vapor load on still, recompressor and de-ethanizer

Practical Fractionator Instrumentation For Natural Gasoline Plant Operators

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THERE are numerous schemes for securing relatively automatic control of product fractionators in natural gasoline and cycling plants as well as refinery vapor recovery systems. However, in many instances operators and even designers often defeat the purpose of the instrumentation with which the tower may be equipped by failing to understand these control methods or to appreciate the effects and side-effects of many of their adjustments to this equipment. This article is intended to explain why we control fractionators as we do and contrast certain control schemes, particularly from the operator's standpoint.

The discussion primarily applies to the problem of depropanizer control. However, it is equally applicable to debutanizers when it is desired to remove substantially all of the butane from the bottom product, and likewise to fractionators separating isobutane from normal butane or from a butanes-plus mixture, or pentane-splitting. In general the control systems discussed relate to problems in which the overhead product is to be a relatively pure hydrocarbon having a constant boiling point or very narrow boiling range.

Two Requirements

There are two fundamental requirements which must be met to obtain satisfactory results with this type of fractionator:

1. Smooth operation. With a satisfactory system smooth operation is essential, but smooth operation does not necessarily infer a satisfactory control system, since this is obtainable with unsatisfactory product separations.

2. Automatic correction. The system must make corrections automatically for deviations from the desired cut point.

The following variable factors will be encountered and the control system must compensate for them:

1. The charge will vary in composition and quantity, or rate. If this were not true automatic control would be unnecessary. The system could be set up with hand valves fixing heating steam, reflux rates and the like.

2. The cooling water temperature will vary with changes in load, weather and irregularities resulting from conditions elsewhere in the plant; therefore, the external reflux temperature will vary.

3. Either the top or bottom product composition must be allowed to change with variations in feed composition if the other product is held to constant quality.

With respect to Variable Factor No. 3, it is possible to separate a substantially pure overhead product, consisting of the lightest hydrocarbon existing in the feed, or to produce a constant vapor pressure overhead product consisting of the lightest and a portion of the next lightest hydrocarbon present. When doing this, the vapor pressure or composition of the bottoms product cannot be controlled and it must, of necessity, include whatever is left over from the feed after the overhead product has been removed.

When applied in reverse the fractionator will produce a constant vapor pressure bottom product and the overhead composition will vary with feed changes. This, in effect, is the conventional natural gasoline stabilizer and also the more modern debutanizer, producing a constant vapor pressure bottom product with the excess of butane in the feed being taken overhead.

The following obvious facts often are lost sight of and are those upon which final conclusions are based:

1. The feed temperature may be held constant, by any one of the several methods to be discussed later. There is a certain optimum feed temperature at which best results will be obtained from the system—i.e., desired separation with minimum reflux rate and heat input. This temperature is not critical and generally may vary considerably from optimum, but it must be relatively constant; automatic control responds with altered heat input or reflux rate to compensate for feed temperature deviation from optimum.

2. The operating pressure may be held constant by any of several means likewise discussed later. This constant pressure can exist only at one point in the system, due to pressure drops in the fluids passing through the system; ordinarily these variations will be slight. It is desirable, however, to have constant pressure, with the pressure control point at, or near, the point at which constant temperature is maintained for system control.

3. Only one temperature in the tower can be held constant (since but one controlled-quality product can be made). The reboiler is considered part of the tower when reboiler temperature control is used.

4. Items 1, 2 and 3, above, are true for all two-product columns making close cuts. It is possible, however, to control both top and bottom temperatures in towers making "sloppy" cuts, where two or more hydrocarbons are common to both products. In this case the variation will be in the degree of overlap of the two products, shown by boiling range and composition.

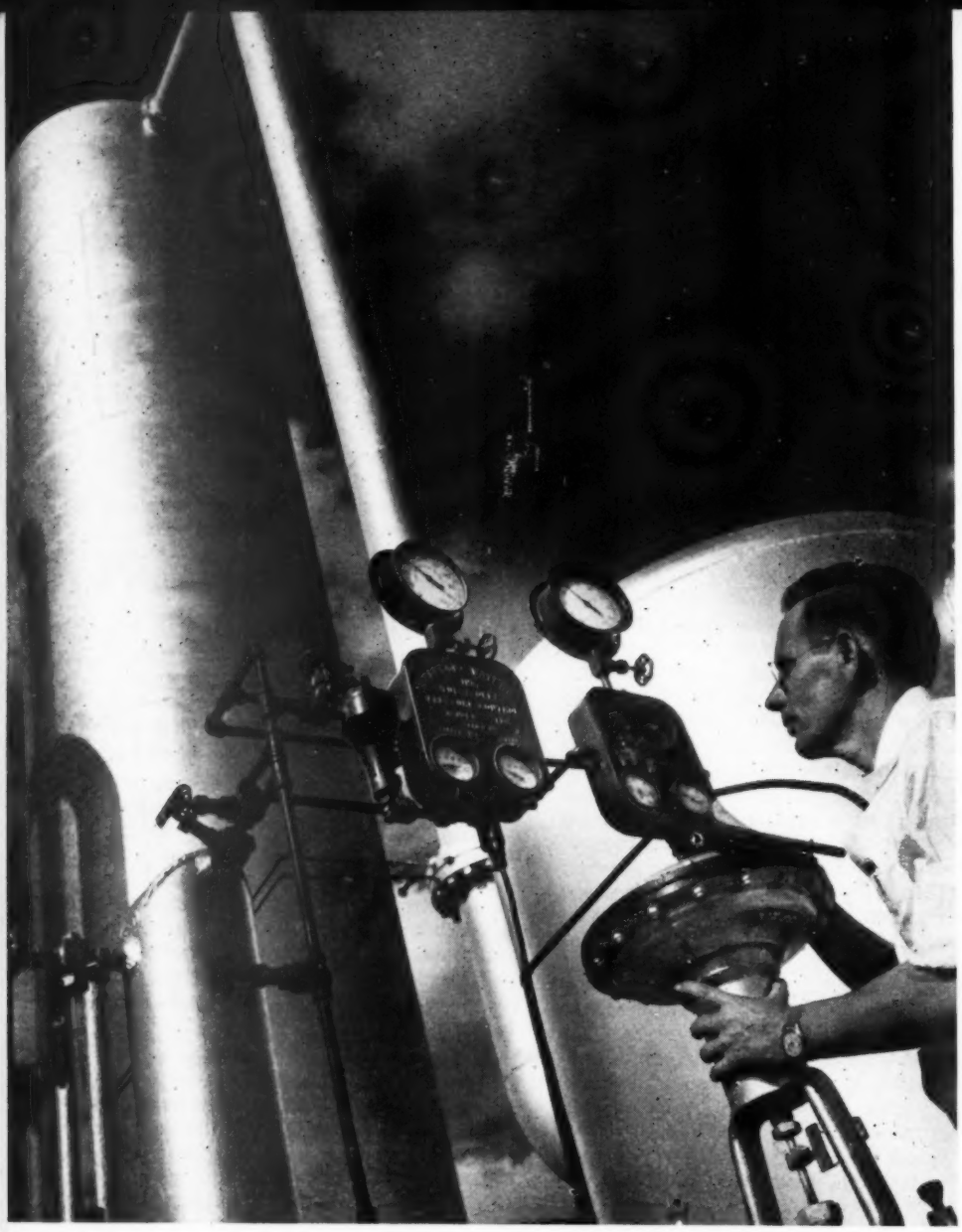
5. The temperature cannot be directly controlled at any point in the tower where a "pure" or narrow boiling range product exists. The top temperature of a tower producing a pure overhead product will remain substantially constant and not until this product becomes badly contaminated will there be sufficient temperature shift to permit "control". So long as the product is relatively pure, changing the heat input will change the rate of evaporation but not the temperature. Attempting to control this temperature is analogous to attempting to "control" the temperature of boiling water at any constant pressure by regulating heat input.

Conventional Scheme

Since this discussion applies primarily to depropanizer control, consider the control of a depropanizer in the conventional scheme involving a cascade series of towers, each taking overhead the light products in logical sequence.

The depropanizer will be located process-wise between the de-ethanizer and debutanizer, taking as feed the de-ethanizer bottoms consisting of negligible ethane, propane and butanes-and-heavier hydrocarbons. The propane is to be taken overhead with a negligible contamination of isobutane, while a likewise small quantity of propane can be tolerated in the bottom product.

There are three possible methods



Pressure controls for a natural gasoline absorber and still. The absorber is in the background, with the still residue scrubber at the right

of controlling temperature, shown schematically in Figs. 1, 2 and 3.

Stabilizer-Type Control

Fig. 2 is the generally accepted method of controlling gasoline stabilizer temperatures, although it also has been used in some plants for depropanizer control. This involves (1) constant pressure control, (2) approximately constant feed temperature control, (3) constant feed rate, (4) constant reboiler outlet temperature and (5) constant reflux rate. The system satisfies the "smooth operation" requirement and can be adjusted to make the required cut between propane and isobutane.

The reflux rate can be set high enough for maximum feed rate and left alone. The feed rate can be readjusted, as necessary, from time to time without any other change. The cut point will not shift unless there is a change in feed composition. The ratio of propane to butanes-and-heavier in the feed may change without requiring altered control adjustments, providing the reflux rate is initially set sufficiently high.

It is for these reasons that fairly satisfactory results can be obtained, in some instances, with this control scheme in depropanizer service.

However, if the ratio of butanes to pentanes-and-heavier changes, or there is any other change in the composition shifting the vapor pressure of the butanes-plus fraction, the bottom temperature controller must be readjusted. Such a change is certain in a plant processing oil-well gas, due to imperfect flow schedules, changing field line pressure, variable separator pressure effects of the weather and fundamental differences in wells.

The vapor pressure of the bottom product cannot be fixed if the overhead is to be substantially pure propane. If this is achieved, vapor pressure of the bottoms will be "whatever it accidentally is."

If the bottoms vapor pressure is fixed and a change in butanes-plus composition occurs, smooth operation will continue but either propane will be included in the bottoms or butane in the overhead—sloppy results inevitably. When the concentration of butanes in the feed increases, a lower bottom temperature will be required. But if a bottom temperature controller is used, some butane will be rejected from the bottoms product and included in the overhead. Vice-versa, if the concentration of butanes in the feed decreases, a higher bottom temperature will be required to maintain a clean separation between butane and propane, and a constant bottom temperature control then will result in some propane being included in the bottoms.

In other words, while a sharp cut can be obtained between butane and propane with this system, it will not automatically compensate for changes in feed composition. Feed composition must be held constant and, if not, temperature controllers must be reset correspondingly, using other column temperatures and weathering of product samples for guidance.

Depropanizer Temperature Control

Fig. 1 diagrams a control scheme designed specifically for depropanizer requirements. Temperature and flow control points of Fig. 2 are shifted to opposite ends of the tower. Feed temperature and rate, and pressure are held constant.

The temperature controller now responds to a shift in temperature a few trays below the top of the tower and bottom temperature is uncontrolled.

Temperature control a few trays from the top is based upon the fact that at this point a binary mixture exists—propane and isobutane. The concentration of isobutane decreases upward from tray to tray near the top and is substantially zero at some point between the control tray and the top of the column. This will be true regardless of the type of control scheme used.

Since isobutane boils at a higher temperature than propane, the temperature on trays below the top tray (where only pure propane exists) will become progressively greater downward. The control tray selection is not critical, although its temperature must be several degrees higher than the top temperature for "good" results.

The hydrocarbons on the control tray should be propane and isobutane only—a binary mixture—consequently the control tray should be located high enough to assure that only this binary exists. At the same time it should be positioned low enough so that a slight change in temperature at this point (enough change to make the instrument function) will not have any detectable effect on top temperature or overhead product composition. This location ordinarily

is seven or eight trays below the top of the tower.

The control tray temperature must be set slightly higher than the tower top temperature when butane-free propane is taken overhead. The upper limit of the control tray temperature, therefore, is that at which the actual tower top temperature (and product composition) is affected. A tolerance of 10 to 15° above the tower top temperature is generally acceptable.

If the required control temperature is unknown, determination is simple. The controller set temperature is adjusted downward and the effect on the top temperature observed. A point will be found where further downward adjustment has little or no effect on the top temperature. This is the maximum allowable control temperature.

If the first adjustment has no effect on top temperature, the control temperature already is within the operating range. In this case, the maximum temperature is found by increasing the temperature setting until the top temperature is affected. A control temperature should be selected about midway between the maximum allowable and the tower top temperature.

The control temperature instrument must not be set below the tower top temperature. To do so renders the system unworkable. The temperature, at the control point, cannot be lower than the tower top temperature. Since the top temperature cannot be reduced to less than the boiling point of propane and still have vapors present, the reflux pump will run away if the instrument is set too low. The control instrument, attempting to reduce the temperature to set point, will increase the reflux flow up to the limit; the flow being limited by pump, condenser, or tower capacity.

If the conditions governing control point selection are understood there will be no difficulties; the system will work beautifully, and respond to changes in charge composition.

Feed Temperature Control

The easiest method of controlling the feed rate is simply to take what comes from the de-ethanizer reboiler. This stream will be controlled by a reboiler level controller, which must work smoothly. An orifice type flow controller may be installed in the transfer line if desired, as indicated in Fig. 1, if a surge tank is used between de-ethanizer and depropanizer. Generally, however, feed to the de-ethanizer itself will be controlled and this will suffice effectively to control depropanizer feed rate.

Temperature control of the feed likewise is simple. As stated previously, this should be relatively constant, but a constant temperature at considerable variance from the ideal temperature will have no serious effect on an automatically controlled depropanizer. A very common method, also shown in Fig. 1, is to heat the feed stream with steam at a constant pressure. The preheater may consist of a steam-jacket over a portion of the feed transfer line to the column—generally 10 to 20 ft. long. The constant steam pressure is maintained with a reducing regulator. In some special cases the heat input will require a shell and tube type preheater. A temperature control instrument may be used to regulate the heating steam. Direct temperature control is desirable in special cases but generally not necessary. In general, the combination of steam regulator and jacketed pipe is very satisfactory as well as economical and trouble free. Once set, this control need not be altered unless there is a radical alteration in feed rate or composition.

In comparing the control schemes of Figs. 1 and 2, it will be noted they each require about the same amount of equipment and are equal from the standpoint of smooth operation. With the system of Fig. 1, it is possible to adjust for optimum results without laboratory tests or weathering of samples, and the system will automatically compensate for changes in feed composition as well as fluctuations in reflux temperature. The system of Fig. 2, on the other hand, must be reset for changes in charge composition, if used in depropanizer service, as the changes otherwise will affect the composition of products.

Two other control schemes also are illustrated in Figs. 3 and 4. The system illustrated in Fig. 3 will accomplish the same results as that of Fig. 2. It sometimes is used when a tower originally was equipped with a reflux meter and no steam meter. The temperature control point is the same, but reboiler steam is controlled rather than reflux flow. Reflux is controlled for constant rate.

It will compensate automatically

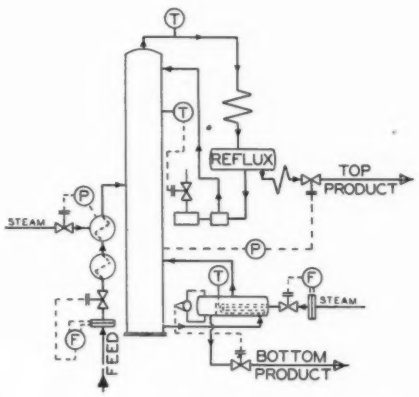


Fig. 1—Control system for pure overhead and variable composition bottom product, fully automatic

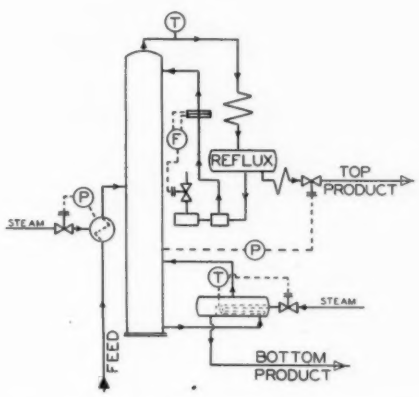


Fig. 2 — Control system for constant vapor pressure bottom product and totally condensed overhead product

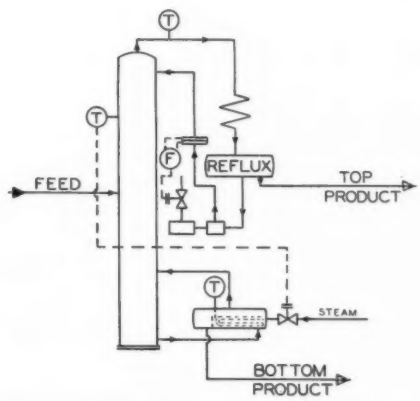


Fig. 3—Alternate temperature and reflux control scheme for pure overhead product. System is fully automatic but has inherently high time lag

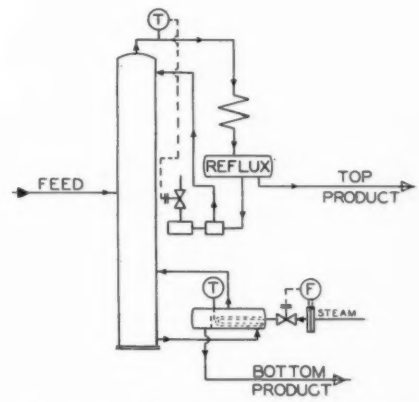
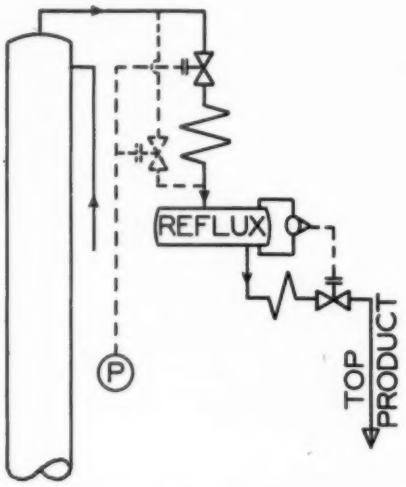


Fig. 4—Temperature and reflux control scheme for a constant vapor pressure overhead product mixture; one component common to bottom and overhead



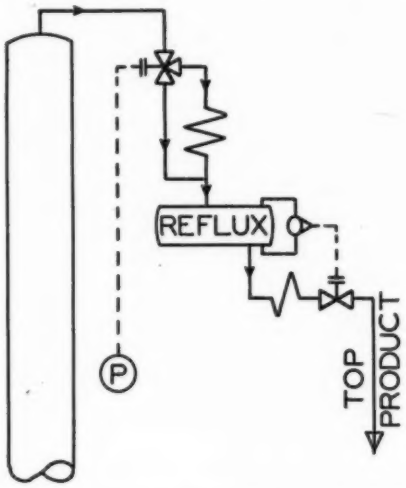


Fig. 5a (left)—Vapor line pressure control system for totally condensing overhead product. Uncertain reflux tank pressure may be improved with bypass valve shown dotted. Fig. 5b (right)—Vapor line pressure control system similar to 5a using "3 way" valve

for feed composition variations, but suffers from one serious objection:

Since heat input to the column is controlled through reboiler steam rate by the temperature controller, a considerable lag is possible between the time when the temperature controller senses a need for more or less heat input and the time when the response actually becomes apparent to the controller. The greater or lesser heat must first be transferred to the reboiler liquid and then rise up the major distance of the column.

Meanwhile, the upset condition may have steadily grown worse, or better, and in the interim the quality of both column products has suffered accordingly. By temperature controlled reflux, the adjustment occurs much more quickly.

The system of Fig. 3 necessarily requires a controller with wider throttling range and incorporating a slower rate of automatic reset. The result is a less sensitive overall system—one that can stand less rapid variations of other factors. Otherwise, this system will do everything that the other system (Fig. 1) will.

LPG-Tower Control

The control system of Fig. 4 gives automatic control, compensates for variations in feed composiiton and yields a controlled-composition overhead product. This is not an alternate for the previously discussed control systems but is intended to produce overhead a controlled vapor-pressure mixture—such as propane and butane. Note here that top temperature control (rather than a few trays down) may be used in this case since a mixture having a comparatively wide boiling range is involved. As in the system of Fig. 1, top temperature control acts directly on reflux rate and consequently tower response is rapid. Heat input is constant through controlled steam flow to the reboiler. Vapor pressure and composition of bottoms cannot be controlled and at least one component of the overhead, butane for example, also will appear in the bottoms.

The control system of Fig. 3, except with temperature control bulb at top, could be used in this case also but would be subject to the same difficulties previously noted for this scheme.

While this system (Fig. 4) is one way to make a propane-butane overhead product of controlled vapor pressure, it is not necessarily conventional or the simplest way of doing the job. Most natural gasoline plants having a depropanizer and producing a stabilized natural gasoline of desired vapor pressure have facilities for producing a relatively pure butane (iso-normal mixed) product.

In cases where propane is produced in greater quantity than can be used in propane-butane L.P.G. products, perhaps the best practice is to operate the depropanizer for a pure propane stream, as illustrated in Fig. 1, and cutting as close to butane as tower design will permit. The stabilizer (or debutanizer) then delivers a butane mixture of high purity overhead. The stabilizer is controlled in accordance with Fig. 2 for a constant vapor pressure bottom product and the excess butanes in the feed thus go overhead.

Manufacture of the propane-butane mixture then becomes a matter of blending to desired vapor pressure rather than producing it in a fractionator. This gives much more flexibility to the plant in that it will produce, at will, pure propane, pure butanes, propane-butane mixtures and stabilized natural gasoline of desired vapor pressure.

Pressure Controller Location

It is desirable to control column pressure for a constant pressure at, or near, the point where constant temperature control is maintained. Exact adherence to this principle is not always practical where temperature control high in the tower is used. Since pressure will not change radically from tray-to-tray, in prac-

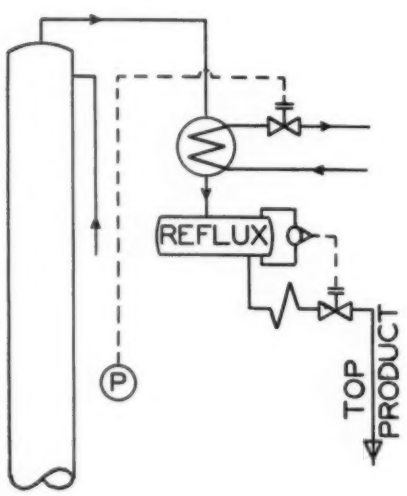


Fig. 6—Pressure control system for totally condensing overhead product. Practical only with shell-and-tube condensers

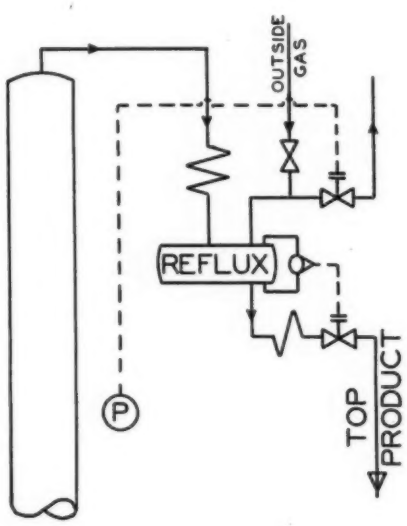
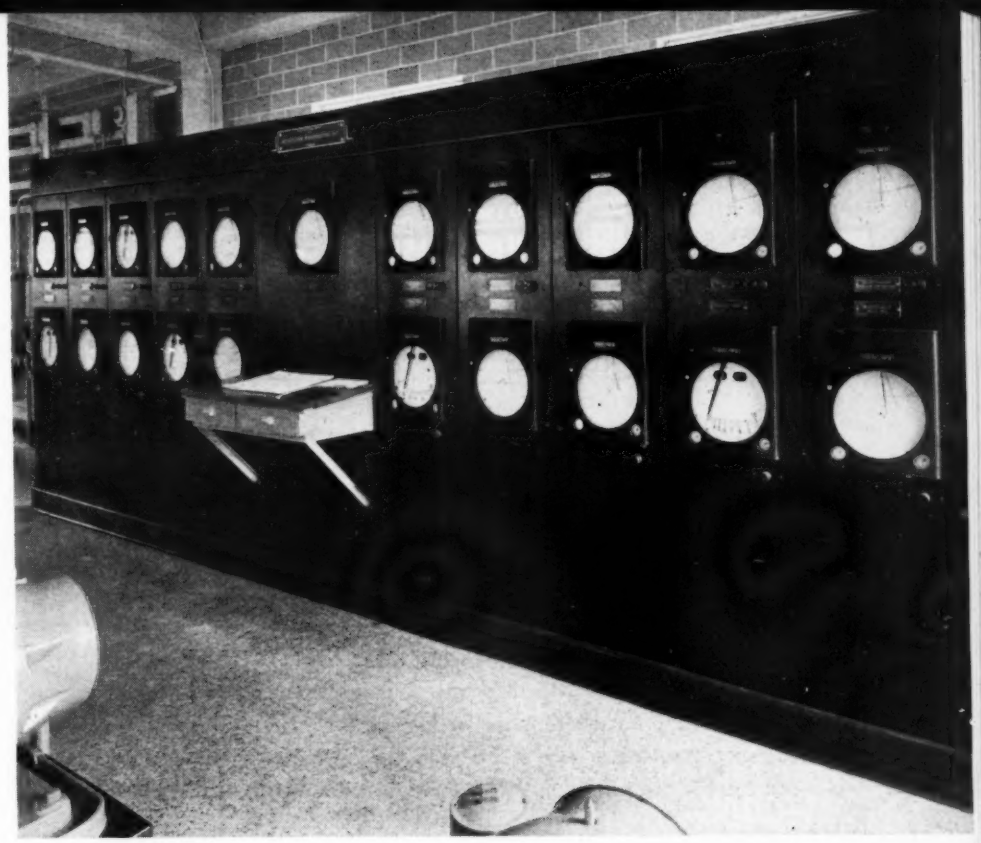


Fig. 7—Pressure control system with outside non-condensible gas supply. Pressure is held by off-gas valve, off-gas being supplied from outside



Typical of the extent to which modern natural gasoline operations are instrumented is this photo of the control room at a large cycling plant, recently put into operation in the southwest. Note the terazzo floor and glazed tile walls

tice the pressure control tap may be located lower in the tower without serious consequences.

Pressure control location may oftimes be dictated by the type of controller used. If a pneumatic or electric transmitter design is purchased, the problem becomes simple and the tower is tapped at the desired point, the transmitter and sensing instrument located there, and the receiver-recorder mounted on the control panel.

If the control point is located much higher than the sensing instrument, difficulty will be experienced. False readings will be obtained due to the effect of liquid head in the pressure-transmission line, because condensate eventually will fill this line from the instrument to the pressure take-off point.

The next important factor to consider is where to apply pressure control—i.e., valve location. The problem is simple with fractionators producing all or a substantial part of the net overhead product as a gaseous mixture such as de-ethanizers or stabilizers not preceded by other fractionators. A diaphragm valve is simply located in the off-gas line. The valve is controlled by a pressure instrument with the control point pressure tap located in accordance with temperature control location.

With depropanizers and debutanizers, or any fractionators where the overhead product is, or may be, totally condensed, the problem is more difficult. There is an off-gas valve for starting, or emergencies, but this valve cannot be used for normal column pressure control since normally there is no off-gas to throttle. The most obvious valve location is in the overhead vapor line. This location is successful in many installations and has some definite advantages as compared to other systems.

There are also some very definite disadvantages. Refer to Fig. 5a. In the first place, a rather large valve will be required because of the large vapor quantity, the temperature and the low pressure drop allowable; therefore it will be an expensive item. When this valve pinches down, a differential pressure between column and condenser is produced; condenser and separator pressure then depends entirely on condenser temperature and condensate composition. With cool condenser water and clean condenser tubes, the reflux tank pressure may be far below the column pressure unless auxiliary equipment is used to prevent this. There may be serious trouble with the reflux pump unless a pump built for a larger differential pressure than otherwise necessary is used. It may also be difficult to move the condensed overhead product to storage without pumping.

Auxiliary schemes commonly used consist of condenser bypass control valves or "3-way" valves, combining vapor line and bypass valves in one (Fig. 5b), and condenser water throttling schemes (Fig. 6). The latter scheme will generally result in the water leaving the condenser at a relatively high temperature. Condenser tubes may become very hot, with the strong possibility of scale depositing on the water side and thereby increasing condenser maintenance.

Use of "Off-Gas"

An auxiliary gas supply from an outside, higher pressure source may be used to maintain reflux separator pressure and thereby column pressure also, if slight contamination of overhead product is not important (Fig. 7). This scheme has been used on stabilizers where the overhead product was a waste product but subject to total condensation. The scheme also may be used on the low pressure still of a two-stage distillation system. Where it may be used, this scheme is excellent. Control is rapid and positive, and the equipment is economical.

The best point to control the pressure of "pure" product fractionators with total condensation of overhead product is on the condensed overhead make line. This, shown in Fig. 1, maintains tower pressure on the reflux accumulator and pump suction, permitting a smaller differential pressure rating for the reflux pump and a less expensive piece of equipment.

Pressure regulation causes "pinching" on this line; liquid in the reflux accumulator will simply back up into the overhead condenser, reducing the condensing surface. The amount of condenser surface exposed is automatically maintained at just the right amount to condense the overhead product and reflux at the set operating pressure. Whenever there is a tendency for the pressure to rise, the control valve opens a little wider, increasing the overhead product stream, dropping the level, exposing more condenser surface and thereby correcting the tendency for the pressure to rise. Obviously, the system will correct in the opposite direction also.

In starting up a fractionator using this system, the pressure may climb slowly since the proper pressure cannot be reached until an overhead product, relatively free from bottoms, is obtained. This is a desirable characteristic of the system since the release of a "sloppy" product to storage at the start is prevented.

From the initial cost and maintenance standpoint this system is desirable since one small valve in the product line does the job. This valve (liquid level controlled) is required with the other systems and, in addition, such other items as large vapor line and condenser bypass valves, "three-way" vapor valve or condenser water control system and a reflux liquid level controller.

Short Cut Process Design to Increase Propane Recovery in Gasoline Plants

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Sanderson-Glendening, Consulting Engineers, Houston

Article 5: Multi-Stage Distillation

Excessively large volumes of non-condensible surge tank vapors may result in a high recovery gasoline plant using a conventional absorption oil distillation system. In this article, the fifth in a series,* the authors discuss how this problem can be reduced or eliminated by the application of multi-stage distillation, which makes possible the operation of the surge tank at a much higher operating pressure than is normally feasible.

IT WAS demonstrated in the sample calculation of the immediately preceding article of this series (refrigerated oil absorption) that the use of a conventional absorption oil distillation system in a high recovery plant is likely to result in the production of abnormally high quantities of still overhead vapors. These vapors are released from the raw gasoline surge tank or make tank. Sometimes called N. C. (non-condensible) gas, they must either be recompressed to an absorber or a de-ethanizer tower, or else recycled to a low pressure re-absorber. In the former case, the recompressor required may be unjustifiably large. In the latter, a very large increment of re-absorber oil may result.

There are two general methods by which the surge tank vapors may be reduced or even eliminated. These are: (1) installation of a rich oil de-ethanizer discussed in preceding articles), and (2) installation of multi-stage absorption oil distillation. It is with the latter that this article will be concerned.

Single-Stage Distillation

Before proceeding to an examination of multi-stage distillation systems, some discussion is in order concerning conventional oil distillation. A detailed process flow diagram of a conventional system (complete except for oil conditioner) is shown in Fig. 18. Rich oil, consisting of absorption oil plus light absorbed hydrocarbon components to be processed in the fractionators, is heated and fed into an absorption oil still. The latter is a bubble tower containing from 16 to 20 trays. Process (stripping) steam enters at the base and serves to strip the light components out of the absorption oil. Reflux, condensed in a primary condenser, enters on the top tray and washes down some absorption oil that otherwise would carry overhead and contaminate production. Some of the process steam condenses within the tower and must be withdrawn from a water draw-off tray located a few trays from the top. The remaining steam condenses in the condensers and is withdrawn from the reflux accumulator and raw gasoline surge tank.

In Fig. 18, a heater is shown applying heat at the base of the still. Whether or not such a heater will be necessary depends largely on the richness of the entering rich oil. In high pressure, high extraction plants, rich oil will contain a very high proportion of absorbed components, sometimes an amount exceeding the amount of lean oil on a mol basis. Under such conditions a heater will be required to prevent a serious fall-back of temperature below the feed point. Such a fall-back would decrease the average stripping temperature and so increase the process steam required.

The function of the primary condenser is to condense reflux only; the net overhead of the still is removed as a vapor from the reflux accumulator and partially condensed in the final condenser. The latter runs at a low temperature, generally with a 5° approach at the cold end, in order to leave as little surge tank vapors as possible. Actually, of course, all the condensing duty might be performed in a single condenser, the reflux accumulator eliminated, and reflux withdrawn from the surge tank instead. The double condensing arrangement has the advantage, however, of condensing reflux at a temperature much higher than that of the final condensation, thereby sav-

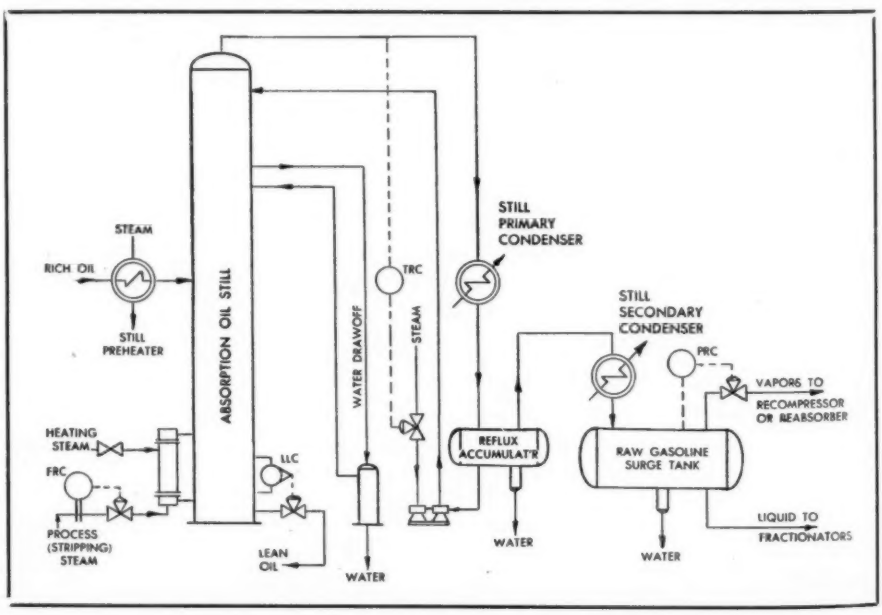


Fig. 18—Conventional absorption oil distillation

* Previous articles in this series were published in PETROLEUM PROCESSING as follows: Article 1, Jan., 1949, pg. 27; Article 2, Feb., 1949, pg. 153; Article 3, Mar., 1949, pg. 258; Article 4, Apr., 1949, pg. 401.

ing considerable condenser surface. For this reason the double arrangement almost always is preferred.

Note that reflux is controlled by the overhead vapor temperature. This makes possible the close control of gasoline endpoint. Pressure on the system is controlled at the surge tank. Incidentally, the pressure established at this point usually determines pressure conditions back through the re-absorber, all the intermediate equipment "floating" on the surge tank pressure.

The choice of the most satisfactory still operating pressure is a compromise between two conflicting effects: high pressure is desirable from the point of view of minimizing surge tank vapors, but tends to increase process steam consumption. The maximum available heating temperature also affects the choice of operating pressure since less process steam will be required at high temperatures than at low. In plants where 150 to 200 psig. heating steam is available, stills are generally operated between 40 and 55 psig. Higher boiler pressures make economical somewhat higher still pressures, and furnace heating (450° and higher) permits operation as high as 70 to 90 psig. without excessive steam consumption. Since the war there has been a considerable trend toward higher still pressures and, as a result, toward higher boiler pressures. Gasoline plant boilers operating at 300 psig. and higher are no longer uncommon.

Two-Stage Distillation

Multi-stage distillation prevents the evolution of large quantities of surge tank vapors by making possible a much higher surge tank operating pressure than is feasible in the conventional system. This is accomplished with no increase in utilities for a given oil throughput. A two-stage distillation system is shown in Fig. 19, the main outlines of which are as follows:

Rich oil from the absorption system and oil heat exchangers is preheated and fed into a high pressure still, a tower which is similar to a conventional still except for its high pressure design. The tower makes a "sloppy" cut (one in which many components are common to both the bottoms and tops), removing overhead most of the lightest hydrocarbon components, but leaving a sufficient amount of light components in the bottoms to enable the tower to operate with little if any process steam. The partially stripped rich oil bottoms are then distilled in a conventional low pressure still, the operation of which differs from the conventional only in that its overhead is less volatile than usual and is totally condensed. The low pressure still tops are then pumped into the high pressure still overhead, preferably ahead of the final condenser in order to promote condensation in the latter.

An alternative scheme is to take a sharp cut in the H. P. still, taking virtually all propane overhead. If this is done, the L. P. still overhead may be charged directly to the debutanizer column to be fractionated into butane and gasoline. This has the disadvantage, however, that the L. P. still overhead is no longer available to promote condensation in the final condenser, and more surge tank vapors will be evolved at any given H. P. still operating pressure.

The advantages of multi-stage distillation are evident. The surge tank operates at a pressure only slightly less than that of the H.P. still and consequently a relatively small amount of surge tank vapors will be evolved. Process steam consumption is low and the equivalent of high pressure single still operation is obtained without the corresponding increase in utilities.

Surge tank vapors may be disposed of in several different ways:

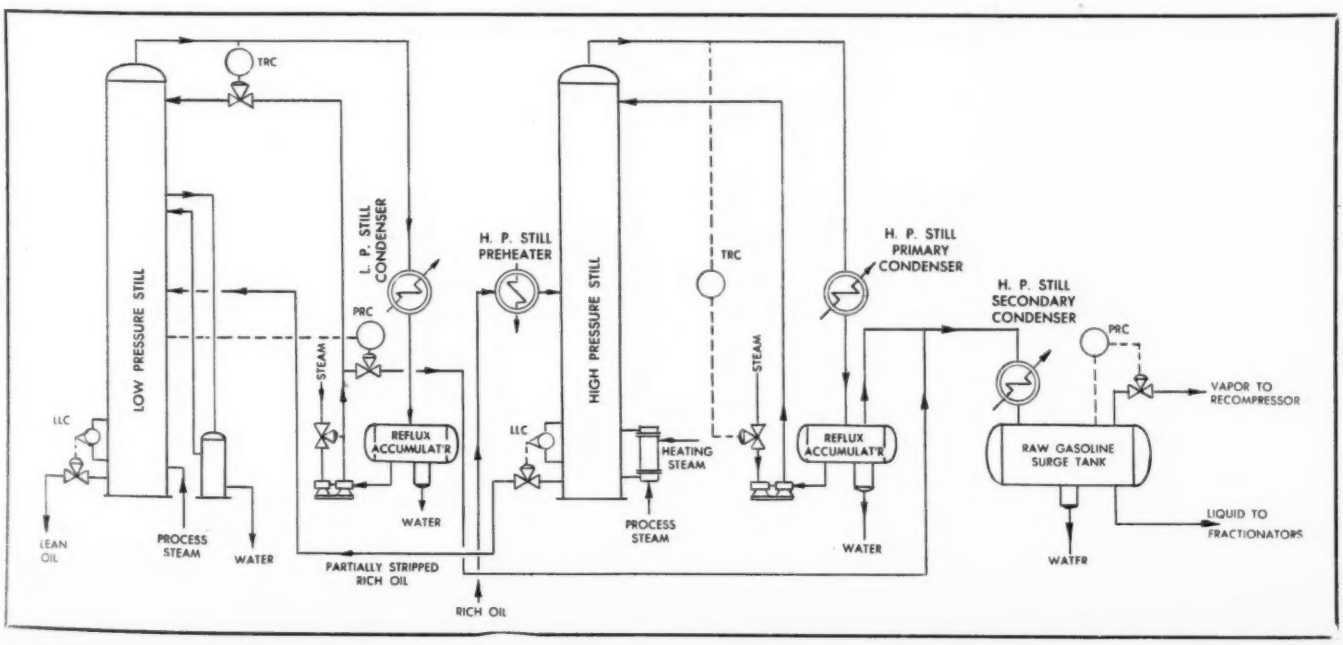
(1) They may be compressed directly to the de-ethanizer, main absorber, or re-absorber. Note that high pressure still operation reduces the horsepower required for this recompression. This is accomplished by a reduction in volume of vapor and also by a decrease in compression ratio. Note also that if wet gas to the plant is being compressed to the main absorber, the recompressor may be dispensed with by recycling surge tank vapors to the main compressors. This, of course, means reprocessing these vapors in the main absorber, but the recycling that occurs within the absorption and distillation system because of this mode of operation will be small provided the vapors are relatively dry (light). This will be the case when the surge tank operates at high pressure.

(2) The recompressor may be eliminated by operating the re-absorber at a pressure lower than that of the surge tank, and recycling surge tank vapors to the re-absorber. This arrangement necessitates a rich oil pump between the re-absorber and still.

Controls

Several methods are available by which the pressure of the L. P. still may be controlled. One of them is shown in Fig. 19 and is applicable

Fig. 19—Two-stage distillation



because the overhead is totally condensed. A pressure controller is shown maintaining constant tower pressure by throttling the overhead liquid product line. With this arrangement the reflux accumulator runs full and the condenser partially flooded. The throttling action of the pressure controller varies the amount of exposed condensing surface which, in turn, varies the condensate temperature and tower pressure.

For example, suppose the pressure of the L. P. still should rise for some reason. The pressure controller will immediately release more overhead product to the H. P. still overhead. Since the reflux rate remains constant meanwhile, this will cause a drop in liquid level in the L. P. still condenser, exposing more condensing surface. Since the hydrocarbon flow through this condenser has not changed, an increase in available surface will lower the temperature and vapor pressure of the condensed material, thereby lowering tower pressure. This type of control is satisfactory for all towers whose overhead is totally condensed, but is applicable only to such towers since any small amount of uncondensibles in the overhead will spoil the control.

Another type of control which is applicable to this and other towers with totally condensed overhead is to have the pressure controller throttle water to the condenser (Fig. 20a). This type of control is more sensitive than the one described above but has one disadvantage: at low throughputs, the water side of the condenser may run quite hot; this may tend to scale up the condenser tubes. Many successful installations of this type are in service, however.

A second alternative control method, applicable only to this particular problem, is to control the L. P. still operating pressure by throttling process steam to the high pressure still (Fig. 20b). This scheme is founded on the fact that the amount of stripping performed in the base of the H. P. still determines the vapor pressure of the L. P. still overhead. It is not applicable, however, where very little H.P. still process steam is required.

Note that in Fig. 19 no water drawoff is shown on the H. P. still. The reason for this is that so little (if any) process steam is likely to be used in this tower that all the steam is likely to pass overhead and be condensed in the condensers. This point must, however, be checked in every case to make certain that there is no possibility of internal condensation.

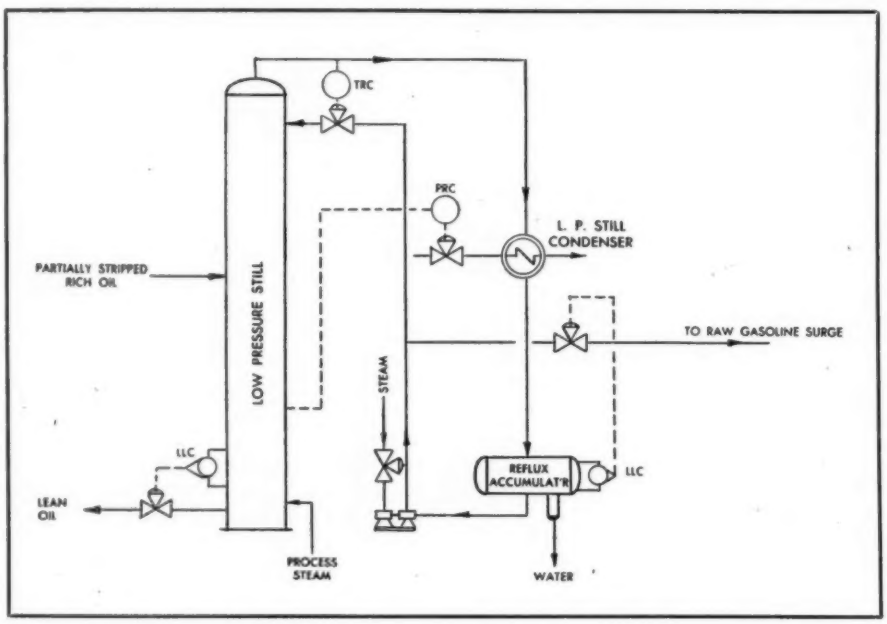


Fig. 20-a—L.P. still pressure control by throttling condenser water

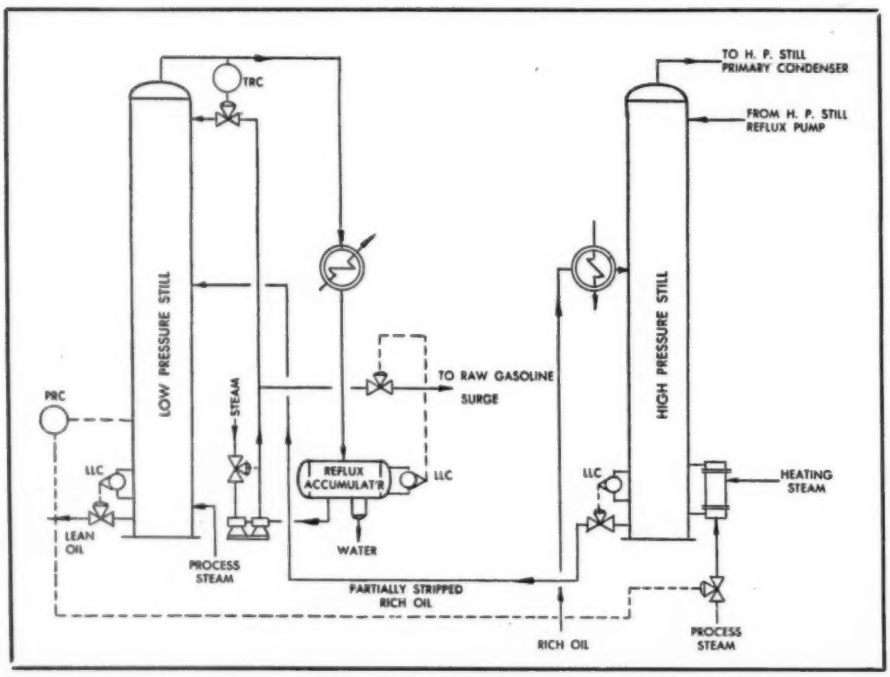


Fig. 20-b—L.P. still pressure control by throttling process steam to H.P. still

Operating Pressure

Operating conditions in the two stills are governed by the following considerations. Very high pressure operation of the H. P. still is advantageous in that it reduces surge tank vapors, but has the disadvantage that:

(1) It requires heavy equipment, a particularly important point with regard to the surge tank which is always a large vessel.

(2) It may result in considerable process steam being required.

(3) Since the re-absorber usually floats on the still pressure, less pressure drop will be available between the main absorber and re-absorber with which to flash out the undesirable components, methane and ethane. Of course, this point doesn't apply if the re-absorber runs at a pressure lower than that of the H. P. still, a mode of operation which was mentioned previously. In many cases it will be desirable to flash the rich oil by the application of heat as well as pressure drop.

Such an arrangement is shown in Fig. 21, which shows the manner in which oil may be flashed between the main absorber and re-absorber. First, rich oil is flashed cold by lowering its pressure; then it is heated by passing it through part of the oil heat exchangers and is reflashed at a slightly lower pressure but at a much higher temperature. The resulting hot vapors must be cooled

and partially condensed before entering the re-absorber. If the flash temperature is properly chosen, rich oil to the H. P. still will have about the same composition as would the pressure-flashed rich oil to the still of the conventional absorption-distillation system. Re-absorber oil circulation will also be about the same.

The proper high pressure still operating pressure must be a compromise between the various points listed above, high enough to keep surge tank vapors down to a reasonable amount, but low enough to prevent points (1), (2), and (3) from becoming serious. The greater is the light hydrocarbon content of the rich oil, the higher may the operating pressure of the still be set without resorting to an exorbitant amount of process steam. Operating pressures between 100 and 200 psig. with 130° to 170° reflux are typical.

It is desirable to minimize steam consumption in the low pressure still by operating it at a pressure somewhat lower than is usual in conventional stills. This pressure depends, of course, on how the H. P. still is operated. Increasing reflux to the latter will provide a sharper separation and will permit a lowering of the operating pressure of the L.P. still. Operating pressures between 10 and 40 psig. are usual for the latter. By proper design, less utilities should be required for the two-stage system than for a low pressure single still system.

Multi-stage distillation is not limited to two stages. If conditions warrant it, three or even four stills might be employed. However, it is unlikely that more than two stills would ever be justified unless ethane were to become a key product.

Method of Calculation

The high pressure still separation is very difficult to calculate with any high order of accuracy. This is true because there may be as many as five or six distributed components common to both the tops and bottoms. Any type of tray-by-tray calculation would be endlessly tedious unless some short cut method were available to give the approximate component distribution and reflux rate. Such a method follows. It is admittedly an approximation only, but should be thoroughly satisfactory for preliminary estimates and it offers a basis from which to continue with more elaborate fractionator methods. Fortunately, great accuracy is not necessary in the calculation of multi-stage distillation systems. Such systems are extremely flexible and a variety of separations in the H. P. still may be made by varying operating conditions in the two stills.

As pointed out by Hengstebeck(1), the component distribution of a "slop-py" cut may be approximated by the relation $\log (d/w) = c\alpha$

where: d is mols of any component in tops.
w is mols of same component in bottoms.
c is a constant for all components in a given separation.
α is the relative volatility of the component with respect to some reference component.

Since $\log (d/w)$ varies linearly with α, a straight line on a semi-log plot of d/w vs. α will give an approximate distribution between tops and bottoms of all components. By trial-and-error a line may be located such that the component distribution gives desirable operating conditions throughout the two-still system: proper H. P. still reflux and bottom conditions, and a satisfactory L.P. still operating pressure.

Since the H.P. still separation is "sloppy" relative to the number of trays ordinarily employed, it may be assumed that the H.P. still operates practically at "minimum" reflux (as if it contained an infinite number of trays). Consequently, a minimum reflux method will be used to obtain the reflux rate. The most convenient method for this purpose is that of Underwood,(2) which is based on constant relative volatilities and constant molal overflow above and below the feed point. A convenient approach to the problem is to regard the still feed as consisting of three components: tops, absorbed components in the bottoms, and absorption oil. Average K's and α's for these three "components" will be computed and inserted in the Underwood equations.

At first glance the above procedure might seem so approximate as to be completely untrustworthy. Some reflection will indicate, however, that the purpose of the H.P. still is not to produce a particular split between certain components, but is to divide the feed into two mixtures with certain average vapor pressures. The Underwood method, applied as above, handles the problem from this point of view and will consequently give a satisfactory result. This procedure will be demonstrated in a sample calculation.

The low pressure still should be designed in approximately the same way as a conventional still. Except that its overhead product is smaller in quantity and lower in volatility than is usual, it operates in the usual fashion. Therefore, the following discussion of ordinary absorption oil stills applies equally to the calculation of this low pressure still.

Absorption oil stills are essentially fractionators separating between the lightest components of absorption oil and the heaviest of natural gasoline. There is sufficient overlap (some components common to both the oil and absorbed material) that the reflux ratio will be relatively low. Any attempt, however, to compute the ordinary still's operation by means of the usual fractionator techniques runs into the following difficulties:

(1) Nothing is known about the comparative amounts of components in the absorption oil.

(2) Usually nothing is known about the comparative amounts of heaviest components in the absorbed material. These are usually merely specified as hexane or heptane and heavier with perhaps some brief information concerning their gravity, initial boiling point, and endpoint.

(3) It is not generally known how much of the heavy absorbed components may be left in the absorption oil without seriously impairing absorber performance.

Because of these difficulties, the most satisfactory design is one based on operating data from existing installations. Lacking such data, absorption oil stills may be computed by a rule-of-thumb procedure based on the following observations:

(1) Process steam consumption is only moderately affected by the absorbed components in the rich oil,

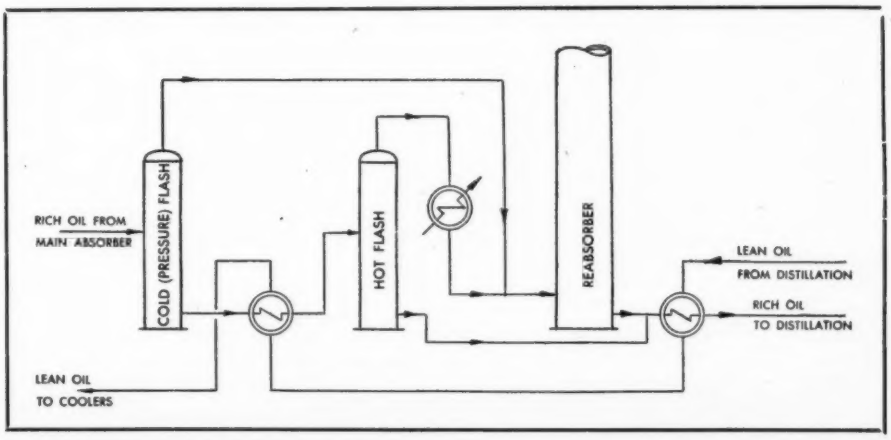


Fig. 21—Flashing of rich oil by reduction of pressure and application of heat

and is mainly dependent on the quantity of absorption oil, operating pressure, and the average temperature of the stripping (bottom) section of the still.

(2) Required reflux is mainly dependent on the quantity of absorbed components present and is affected indirectly by the oil circulation, temperature, and pressure only insofar as it is slightly affected by process steam consumption; ie. some reflux will be employed merely to condense steam internally, without contributing anything to the separation itself.

In stills operating at about 50 psig. with 150 psig. boiler pressure (about 350° in the stripping section), a steam rate of 0.15 lb. of steam per gallon of absorption oil may be assumed.

The amount of reflux required for the separation, regardless of operating conditions, may be assumed to be 150% of the net overhead. The amount of steam condensed internally must then be computed and sufficient external reflux added to perform this condensation.

Top tower temperature and reflux temperature (if a double condensing arrangement is used) cannot be computed, because an accurate dewpoint calculation depends upon a knowledge of the heaviest ends. The only thing to do, therefore, is to assume both of these temperatures, and compute overhead steam and reflux condenser load accordingly.

Inaccuracies in the choice of those temperatures will not seriously affect the sizing of the primary condenser since the temperature approach in the latter will be very large in any case, and the heat load is mainly dependent on the reflux quantity. With 50 psig. operation, reflux will usually condense at about 170° and the top tray will run at about 220°.

These temperatures may be adjusted for somewhat different operating pressures by determining the temperatures at which the K's of some fairly heavy component, hexane for example, will be the same as at the above reference conditions. Reflux composition may be obtained approximately by conducting a dew point calculation on the net overhead at the assumed reflux temperature. This calculation will have no significance, however, with respect to checking the assumed reflux temperature.

Note: ordinarily in a two-stage system, the L.P. still condenser duty will be relatively low and a single condenser arrangement will usually be satisfactory. With a single condenser, reflux temperature is definitely known although the top tray temperature remains in doubt for reasons discussed above.

Whether or not a heater at the base of the still is required may be determined by conducting a heat balance around the still. First the heat balance is performed assuming no heater is necessary and the temperature drop from the feed to the bottom determined. If this drop is excessive, say more than 20 or 30°, a heater should be employed. The heater load, if required, is then determined by a heat balance around the tower based on the assumption that lean oil leaves at the base at the maximum temperature practically obtainable (usually about 20° below the saturation temperature corresponding to the boiler pressure).

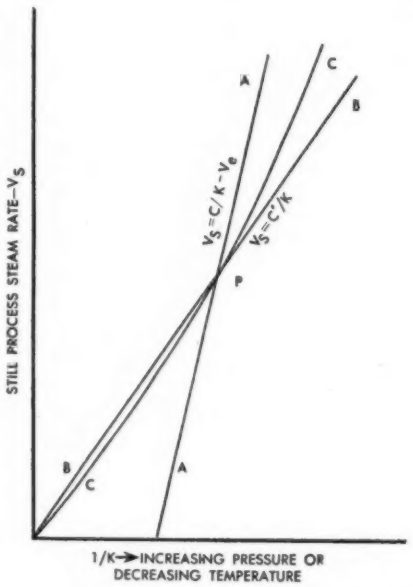


Fig. 22—Method of estimating still process steam

The only remaining design problem is the manner in which process steam consumption varies with still operating conditions. As was mentioned previously, the steam quantity may be reduced by lowering tower pressure or raising the average stripping temperature. Unfortunately, however the exact nature of this variation cannot be computed. Instead, the steam rate must be roughly computed and judgment applied to arrive at a design figure.

It may be assumed that proper stripping in all absorption stills requires an approximately constant stripping factor, $S = KV/L$, where V and L are effective vapor and liquid loads in the stripping section, and K is the equilibrium constant of some key component. Presumably a certain fixed percent of the latter must be stripped from the oil in order to assure proper absorber performance. Hexane will be assumed to be a typical key component. It is improper to assume that the ratio V/L is given by mols steam per mol lean oil, since light hydrocarbon vapors also perform a considerable amount of stripping. Therefore, rewriting the definition of the stripping factor to include light hydrocarbon liquid and vapor:

$$S=K(V_s+V_e)/(L_o+L_e) \quad \ldots . \quad (29)$$

or: $$V_s=S(L_o+L_e)/K-V_e \quad \ldots \quad (29a)$$

where: S is the stripping factor
L_o is mols lean oil
V_s is mols steam
K is the equilibrium constant of the key component at average stripping section conditions
L_e is effective light hydrocarbon liquid load in the stripping section
V_e is the effective light hydrocarbon vapor load in the stripping section

Assuming S, L_o, L_e, and V_e are all constant, Equation (29a) reduces to $V_s=c/K-V_e$, where c is a constant.

This relation is shown as a straight line A in Fig. 22, which is a plot of V_s vs. $1/K$. Line A has been drawn through some known reference point, p, such as the value that was mentioned previously: 0.15 lbs. steam per gal. of lean oil at 350° and 50 psig. Also shown in Fig. 22 is line B, corresponding to the relation, $V_s=c'/K$. This would be the proper relation if light hydrocarbon vapors performed no stripping. The actual variation of V_s with $1/K$ will lie somewhere between lines A and B as indicated by curve C.

This is true because the light vapors, V_e, become progressively less effective at lower steam rates. Or to put it differently, a molal stoichiometric stripping diagram will show increasing curvature of the equilibrium curve at low steam rates, an effect which cancels the effectiveness of light hydrocarbon stripping vapors. (See the second article of this series for the construction of such a diagram).

The exact location of curve C can be determined only by experimentation with an existing installation. Therefore the procedure is to compute the steam consumption given by $V_s=c'/K$ (line B) and apply proper judgment in correcting the result. Note that relative to point, p, an increase in $1/K$ increases steam consumption beyond that indicated by the above relation. Since K is approximately inversely proportional to pressure, this corresponds to the fact that an increase in still operating pressure brings about a proportionally greater increase in steam consumption.

Another "judgment factor" should be applied to account for the volatility of the overhead. If the overhead product's volatility is low, as is the case in the low pressure still of a two-stage system, more steam will be required than would be anticipated from the operating conditions.

References
(1) Hengstebeck, R. J., *Trans. Am. Inst. Chem. Engrs.*, 42, 309 (1946).
(2) Underwood, A. J. W., *J. Inst. Petroleum*, 32, 614 (1946).

On this and the following pages are presented staff-written reports and reviews of some of the more important and interesting papers presented at the recent Division of Refining meeting of the American Petroleum Institute in Houston, April 4-7. We regret that space limitations prevent publication of the complete papers, but single copies can be obtained from A.P.I., 50 West 50th St., New York 20.

ORGANIZING PLANT MAINTENANCE

HOW modern techniques of business and industry are being applied in some refineries to reduce the cost of maintenance work and the amount of operating downtime, was described at the session of the API Refining Division in Houston devoted to Management of Refinery Maintenance.

Maintenance has been the neglected stepchild among refinery management problems, Elliott B. McConnell, vice president of Manufacturing, Standard Oil Co. (Ohio), presiding officer, stated in opening the session. However, the high capital costs of modern refining units today make each hour of non-operating downtime saved well worth the effort in planning and supervision, he said.

To underscore the importance of the maintenance problem to plant supervisors and managers, Mr. McConnell said that the total maintenance cost in U. S. refineries today is close to $500,000,000 annually. In his own company's refineries he said that it required the services of about half the employees to keep the plants running. Properly administered maintenance requires the highly co-ordinated use of men, methods and tools, he brought out.

Four methods for the scientific approach to the management of refinery maintenance were given in the four papers presented at the meeting:

1—Use of modern machine accounting as a guide in controlling maintenance costs.

2—Use of daily work schedules, guided by longer-range surveys, to secure more efficient use of man-hours of labor.

3—Establishing preventive maintenance programs to anticipate and ward off downtime for repairs and replacements of equipment.

4—More efficient layout of physical maintenance facilities in refineries to reduce maintenance cost and downtime for operating units.

The four papers devoted to the above subjects are reviewed below:

Accounting System Shows up Leaks In Maintenance Expenditures

SCIENTIFIC control of maintenance costs, the same as for any other industrial operation, involves careful planning to meet specific objectives, execution according to plan, and frequent comparisons to gauge the success of the resulting performance, said R. S. Stewart, Standard Oil Co. (Ohio), in introducing his discussion of this phase of the subject.

In his paper "Control of Maintenance Costs", of which H. A. Gustafson of the same company was co-author, he described the machine accounting procedure used by this company. Automatic business machines were installed to gather, assimilate and report basic maintenance statistics. The machines translate alphabetical and numerical data upon small punched cards, segregate these data that are desired, make calculations upon them, and print in report form the resulting information.

The machines do most of the clerical work automatically, making available in a matter of minutes information which, under the former manual system, would have taken days to report, with the possibility of human errors always present. The information includes data on man-hours of labor, by crafts and by operations, and the details for all materials. From the data the following types of control reports are quickly available, as illustrations:

1—Labor and materials for maintaining and operating every producing and service unit in the refinery, and also the expenses accrued by each refinery account.

2—Expenditures of labor and material, further subdivided by type of

equipment, period of time, and amounts of material used.

3—Labor expenditures tabulated by individual jobs, crafts involved, man-hours, individual pieces of equipment, and amounts of overtime.

Before making use of the machines, several changes in the company's accounting procedure were necessary. The first involved re-classifying and numbering chargeable accounts in each refinery, including the refinery producing units, operation expense accounts, general expense, overhead accounts, service units and so on. The desired subdivisions for further cost analysis were also determined.

Uniform Procedure Used

The procedure for obtaining maintenance information is uniform in all company refineries. A work-order system forms the basis. The use of any labor or material requires a written request, which is made on prepared forms. Each request has three important elements; (1) an identifying number, (2) detailed description of the job requested, (3) signature of an authorized requester.

The written requests are forwarded to a central maintenance department office, where they are reviewed, and the materials, crafts and man-hours necessary for the task are estimated. On large jobs field engineers assist in this step. Provision for the work is made in the plant man-hour schedule. One copy of the request is sent to the accounting office as notice that labor and material costs will be charged to it.

Workers' tickets and data on requisition of material and equipment are forwarded every day to the accounting office for daily tabulation and recording. When the work is completed the accounting office is notified. Labor and material costs for the specific task are accumulated at desired periodic intervals, and tabulated and become the basis for numerous control reports.

Among examples of the control reports and their use, each month the costs for each refinery account and subdivision are totaled. These amounts are compared with previous months and with the average of months in previous years. These reports are issued to department superintendents and foremen. They bring to attention individual instances where costs are too high, and the cause can then be determined and the necessary remedy provided.

A second report, of value to plant managers, assistant managers, and mechanical superintendents, involves the mechanical man-hours used. These are shown for each operating unit and a further breakdown is made for each craft. This report is of value in comparing maintenance costs and time spent on individual units and processes. It helps to determine the work load by areas of the plant.

Another report distributes for the refinery division the total man-hours spent for each division by emergency, rush, routine or shutdown work orders. This check restrains emergency and rush orders. Chronic offense may indicate inadequate preventive maintenance, improper equipment, or poorly trained mechanics.

A detailed labor and material report is supplied periodically on unit shutdowns which aids greatly in preparing schedules for the next shutdown. As a further aid to controlling maintenance, a monthly incomplete work-order listing is made. This shows at a glance whether work is accumulating or whether the backlog is only normal. Blanket work-order costs are reviewed periodically and large amounts which are out of line with normal experience are investigated in detail.

Reports on costs of maintaining and operating specific pieces of equipment are especially helpful in making repair and replacement decisions. Excessive costs may indicate improper maintenance, application or design in the individual instance.

The automatic business machine installations used in Standard Oil Co. of Ohio refineries were supplied by the International Business Machine Co. This concern also supplies the work-order forms, job tickets and material-requisition cards used in the installations. The machines are rented on a monthly basis. The rental cost varies from $722 per month for the refinery with 17,000 b/d crude throughput to $1015 for the 40,000 b/d crude throughput plant. In the former case the clerical personnel required is four, in the latter case six. The company has made no material change in its total clerical force since the installation of the machines, the same personnel now preparing many additional reports for company and governmental use.

In presenting the paper Mr. Stewart emphasized that discretion must be exercised in making the selection of the information put into the punched cards used in the machines. Only the information put into the cards can emerge in the final reports, he said, and it is important to make sure, both that needed data is included, and that superfluous information is omitted. In the discussion on the paper this point was also brought up. One refiner also advised a preliminary educational program before the machines were installed to better fit the plant foremen to supply the desired information to be incorporated in the business machine cards.

Daily Maintenance Work Schedules Expedite Jobs, Prevent Delays

A DAILY work-scheduling procedure including maintenance jobs, as used in the Port Arthur refinery of The Texas Co., was described at the session on "Management of Refinery Maintenance" in a paper prepared by H. H. Linnell of the Port Arthur works.

The daily scheduling in general requires that all maintenance work that must be done the following day be listed, that the number of men required be balanced with the number available, and that the supervisors be informed in time to allow them to develop any detailed knowledge of the work they need and to select and instruct their men.

The procedure also allows the supervisors time to arrange for material, tools and equipment deliveries in advance of the time the men report to the job. Consequently, each workman is equipped with the necessary information, material and tools to start each day's job without delay.

The system which was started 20 years ago is essentially the same today. It is used for scheduling all turnarounds of process units, all construction, all routine maintenance and any other work performed by company construction and maintenance labor—with certain exceptions. The exceptions apply to work performed in the shops and by some permanently assigned employees.

The daily scheduling procedure may be divided into three steps:

1—The estimates of the next day's manpower requirements made up or assembled by each area engineer. (The Port Arthur plant is divided into three areas for administrative work.)

2—The balancing of such requirements with the forces available for performing the work by the schedule engineer.

3—The assignment and instruction of gang leaders and workmen by supervisors of each department in the construction and maintenance division responsible for carrying out the scheduled work.

The day-to-day work scheduling in the Port Arthur refinery is guided by regular annual, semi-annual, monthly and weekly surveys of the refinery's man power requirements. The annual forecast, made for budgeting expenditures, gives the long-

range picture of the construction and maintenance work planned for the year, as well as the overall manpower needed to accomplish it. The forecast is based on the refinery production schedule, which outlines what equipment will operate, and over what periods of time and on the anticipated major investment work to be undertaken.

The semi-annual labor forecast is prepared quarterly and covers an estimate of the labor requirements for the next two quarters. The number of employees from each craft needed daily is estimated under the following classification:

1—Overhead and supervision.

2—Maintenance: (a) routine, (b) miscellaneous, (c) other maintenance.

3—Inspection and testing of process units.

4—Construction and major expense items.

What Maintenance Includes

Routine maintenance includes running repairs and preventive maintenance that requires fixed numbers of men on the same assignments day after day, the year around.

Miscellaneous maintenance covers shops and some field labor used on such work as manufacture or recovery of material, operation of trucks, etc., on which the same relative number of men is used daily.

Other maintenance includes labor used on painting, cleaning, and repairs to exchangers and tankage; repairs to pumps, lines and other equipment, and other repair work not handled by the routine repair crews.

Labor requirements for routine and miscellaneous maintenance, turnarounds of process units, construction, and some major expense items, as well as supervision can be forecast fairly accurately. Past experience governs the estimates for requirements for other maintenance. The demand for maintenance labor is kept as uniform as possible throughout the year by careful timing of unit shutdowns, and by fitting the construction and major expense work into the general work planning.

Stability of plant construction and maintenance forces is also obtained by the use of contractors' forces on major replacement and new investment items wherever such work cannot be fitted into the program of work to be performed by company workmen.

The monthly labor forecasts furnish a detailed picture of the work to be carried out in the coming month. This enables revisions to be made in the longer forecasts because of unanticipated changes in operating requirements, the need for cleaning or repair of units that could not be foreseen or definitely fixed in the longer range planning, because of inaccurate estimates of time required to perform scheduled jobs, or because of emergencies or other factors that disrupt long-range planning.

In making up the monthly work schedule, each refinery department submits an estimate of the man-hours for each craft it will need in maintenance work. The total is balanced with available manpower in a monthly meeting of the plant superintendent and department heads. Minor differences in labor demand and supply are left for the daily scheduling.

The weekly forecast supplements the daily schedule by providing a labor balance made about the middle of each week by the schedule engineer. Estimates of the man-hours required by crafts are made, and of the average available daily labor supply. The week's work is then adjusted to the number of men available by deferring less urgently needed work, or by advancing work originally scheduled to be done later. If necessary, priority is assigned the various jobs from the standpoint of production requirements.

It has been brought out earlier that maintenance forces required for turnarounds are scheduled under the plant's daily work schedule system. The long-range planning for the turnaround work usually starts when the six months' labor forecasts are prepared. A six months' test schedule is made up about six weeks before the start of each semi-annual scheduling period. This test schedule gives the dates fixed for taking each unit out of operation and the number of days it is expected to be down.

For high-pressure units the operating schedule between inspection is rigidly held to a maximum of six months. On most other units some tolerance is permitted to allow holding the general manpower requirements to as uniform a basis as possible. Other factors which govern the choice of the shutdown date for each unit are its general condition, necessity for meeting production requirements and the anticipated time for receiving materials needed for major replacements or repairs.

The value of the work scheduling system at the Port Arthur refinery, as in any oil company plant, it was brought out, rests on the active and wholehearted co-operation of capable supervisors. They must be constantly alert to see that the workmen are correctly informed and instructed, that they are supplied with the proper materials and tools, and that they are promptly re-assigned when delayed by factors beyond their control.

Preventive Maintenance Wards Off Failures of Plant Equipment

PROVED benefits of the preventive maintenance system installed by Esso Standard Oil Co. in its six refineries which process about 500,000 b/d of crude were related, at the API session on Management of Refinery Maintenance, by R. W. Tryon, of the company's New York offices.

The system is based on the anticipation of the possible failure of an operating unit or a piece of its equipment, and attempts to alleviate the cause and thus prevent or materially postpone the actual shutdown. Thus the training of operators in the proper handling of their equipment, training of mechanics in the performance of their trades, and the application of highly specialized knowledge in the field of design and maintenance of equipment, all come within the scope of preventive maintenance, as included in the Esso program.

The zone system is employed in the company's maintenance organization, the number and size of zones in the individual refinery being governed by the magnitude of the investment to be maintained. Maintenance and construction in each zone are supervised by a zone engineer, who reports to the department head of maintenance and construction. Each zone is subdivided into areas containing several operating units. The area engineers reporting to the zone engineers are key personnel in preventive-maintenance matters. They co-ordinate the functioning of the crafts within their area, and they also provide liaison between the field problems and service groups, such as the mechanical engineering and inspection departments.

The Standard Oil Development Co. functions in the preventive maintenance program by serving as the means for exchange of information between the refineries and the technical groups. In addition, it provides central engineering service and sponsors specialized forums dealing with metal inspection, pumps, compressors, welding, corrosion, instruments and so on.

Training programs for operators and craft workmen are an important part of the Esso Standard preventive maintenance system. The training of the future operators of

new process units is started long before construction of the unit is completed. Classroom instruction on the theory of the process is conducted by process engineers. Key operators are sent as observers to another plant where the process is in use. Particular attention is given to the details of starting up and shutting down the equipment. As construction proceeds, groups of operators visit the site to trace the lines and circuits of the unit and to familiarize themselves with the interior of the equipment.

Also Train Mechanics

Programs to develop more first-class mechanics are a part of preventive maintenance in the Esso refineries. In the case of machinists, for example, a dual course of shop instruction and classroom study has been set up. The course advances through four phases from helper to machinist second-class, totaling four years of shop instruction and over 200 hours of classroom study.

The shop program starts with nine months' minimum experience as a helper; advances through experience on saws, lathes, milling machines and, finally, to precise operations on specific machinery such as centrifugal pumps, turbines, gas engines and compressors. The study program starts with freehand lettering; covers necessary phases of mathematics; and eventually the figuring of gears, lectures on metallurgy and descriptions of the design and functioning of machinery. The study program is given on company time. Instructors are made available, outside of regular working hours, to those who have difficulty with the academic studies.

Recognizing that many maintenance problems with equipment arise from its improper lubrication, one Esso refinery includes the lubrication of equipment, in all except special cases, in its preventive maintenance schedule. The regular operators supply the lubrication service, since they are present on the equipment around the clock, and they are especially trained for this work.

Have Prepared Lubrication Manual

The first step in this program has been the preparation of a lubrication manual for each operating unit in the refinery. The manual defines the responsibility for every lubrication requirement on the unit as, for example, between the operating personnel, machinist department, electric department. The mechanical departments are responsible for the proper lubrication of equipment before it is released to the operating department for operation, after repairs, or after new installations have been made. The manual contains a simplified plot plan of the unit showing the location of each pump and a section on lubricating procedure for the unit's equipment.

In addition to providing manuals, there are also provided the wrenches, grease guns, and other tools necessary for the lubrication work. The operators are encouraged to tighten packing, stop small flange leaks and to do all small jobs to avoid continuous calling in of mechanics.

Bearing failures have been reduced about 25% under the lubrication program as a part of preventive maintenance and the plan is now being extended to cover all pumps and machinery in the refinery.

Esso Standard's larger refineries are equipped with 4000 to 5000 pumps of both centrifugal and reciprocating types, hence the preventive maintenance program has been intensively developed for this item of equipment. Performance records and other pertinent data are kept for every pump installed, by a group attached to the machinist division, which also maintains records on all other refinery machinery and heat exchangers.

Keep History, Data on Each Pump

Complete manufacturers' information on each pump is filed and a running history is kept on the repairs and part replacements. The records group issues the storehouse orders for pump parts and also specifies the number of spare parts to be kept on hand for each pump, and the storehouse automatically reorders each part when it is drawn for use.

The pumps in a fixed area are assigned to a field machinist, who visits all of them daily to check packing conditions and noise or bearing-temperature indications. A memo on all repair work is sent to the pump records department. One refinery circulates a "morning report" covering the 24-hour status of pump and machinery difficulties throughout the refinery.

The pump records are studied by the mechanical engineering department and are the basis for improved specifications. New materials and experimental changes are constantly being tried on pumps in difficult service.

The refinery-loss reduction program at Esso Standard refineries has stimulated better maintenance on pumps by means of a procedure to measure and record pump-gland leakage. Over a 3-year period, average gland leakage has been reduced 30%. A newer development, which is gaining prestige in preventive maintenance, is the use of mechanical seals to eliminate leakage from centrifugal pumps. So far single mechanical seals are widely used only on light products pumps, where the elimination of seal oil, packing trouble and product degradation shows an annual payout in excess of 100%. The highest pressure and temperature where mechanical seals are now used are 315 psi gage and 275° F. respectively.

May Check Pumps Every 6 Months

The plan is now being considered of checking the performance of key pumps every six months, to indicate internal deterioration and to permit a scheduled overhaul, if necessary, before the pump breaks down. Most operating unit pumps are opened for inspection during major turnarounds. If there is any question about their condition, they are sent to the shop and rebuilt as required. One of the items which is being checked on all light-ends centrifugal pumps through the Esso Standard refineries is the condition of drain connections.

Esso Standard's larger refineries contain 5000 or more electric motors and preventive maintenance is also applied intensively to these items. Those on operating units are checked during general inspection turnarounds. This inspection includes the measuring of insulation value of feeders and motor windings, checking of relay settings and of starter and lubrication.

On all large operating units the motors are taken to the shop for overhauling at intervals from one to two years. Windings are washed with solvent naphtha, baked and varnished. In areas where lightning storms are prevalent, 25% of all motor failures were found to be due to this cause, and lightning protection for the feeder systems is being extended.

Most of the turbine drivers are on spare pumps. The preventive maintenance program here includes a check every four months which includes "breaking" couplings, running up to speed and establishing the revolutions per minute at which trip mechanism functions.

Include Compressors in Program

The use of gas-engine-driven compressors has developed to the point that a systematic preventive maintenance approach is required. One refinery, which has 153 units ranging from 124 hp. to 800 hp. requires an inspection and maintenance force of 24 machinists and helpers. The overhaul schedule is set at 3000 hours for the older machines and 10,000 hours on the modern angle and V-type machines. The scheduled overhaul includes complete dismantling and replacement of necessary parts, such as piston rings and valves. All units are checked on a 1000-hour schedule. Another refinery has an engine-test group in the field which checks compressor performance on a rotating schedule. The work includes checking ignition systems, taking indicator cards and setting

the best schedule on clearance pockets.

The maintaining of automotive equipment used at the refinery offers a good field for preventive maintenance. A large number of motorized units are used such as bulldozers, cranes and lift trucks. The payout for getting supervisors from one job to another in quick time justified a sizable fleet of automobiles. Trucks are often used to move groups of workers from one job to another. Scheduled preventive maintenance inspection is provided for all automotive equipment and detailed records are kept of all repairs.

The practice today in Esso Standard refineries is to install most pipe on overhead supports and to relocate piping above ground on a program basis. Cathodic protection of buried pipe has been found competitive in some instances and where used it is included in the preventive maintenance program.

Reinforced gunite has been found to provide a successful method for protecting storage tanks from internal corrosion, where the tanks are not too greatly deteriorated. This work is included in the Esso Standard general preventive maintenance program, as is also the work of installing specialized types of lining to combat corrosion in the high velocity catalyst piping in fluid catalyst cracking plants.

Improved Shop Layout and Tooling Help Lower Maintenance Costs

THE cost of modernizing the physical maintenance facilities in the average refinery will be returned to management in less than five years, the API Refining Division meeting on Management of Refinery Maintenance was told. Poor tooling and disorder in arrangement of shops and stores is common, it was stated in a paper entitled "Maintenance Shops: The Layout and the Tooling", prepared by Ditmas Bromley and Henry P. Evans, of C. F. Braun and Co., refinery engineers, Alhambra, Cal.

Process units are fully equipped with everything to cut down operating labor and to improve their effectiveness, such as automatic controls, fine instrumentation and good buildings, it was pointed out; while the maintenance force is required to work with makeshift and obsolete equipment and with its buildings scattered throughout the refinery property. The reason is that management itself has overlooked the dollars wasted in maintenance under these conditions, it was said.

The maintenance shops in the usual refinery are located in buildings not designed to house these facilities and scattered throughout the refinery. The buildings usually have no planned arrangement. When several shops for various crafts are located in one building, they are often partitioned off so, in effect, they are scattered buildings.

With almost any routine repair job, it is seldom that one craft working alone can complete the work. Often the whole job, or its parts, must go from the unit to cleaning, to the weld shop; thence to the machine shop and, finally, back to the unit or into storage. The handling involved, through the scattering and separating of the maintenance shops greatly slows down the flow of maintenance work and adds to its cost.

In many instances also, the machine tools used in the maintenance shops are worn out and obsolete. The machinists, mechanics, welders and other crafts waste many hours nursing such machines along and scheming up special devices to handle jobs far beyond the capacity of the machines.

Based on the dollar value of the materials, maintenance uses about 85% of the stores in the refinery. Usually, however, the stores are scattered over the plant, in open area, in hand-me-down sheds left over from construction days, in abandoned units, even in the tank farm. And the stores are frequently moved.

Incoming supplies must be unloaded, sorted, classified and laid away in orderly fashion. Later they must be found, dug out and delivered to the point of use. All this requires a great deal of handling and, too frequently, the handling must be done with a few hand trucks and rollers, with labor doing the greatest part of this work.

Also vital to efficient maintenance are the tools for handling the apparatus at the operating unit and for hauling from unit to shop and back. Tools and equipment of this kind should include built-in air hoists, fork-lift trucks, cranes; trucks and trailers and finally good roads. Where such equipment is found it is too frequently obsolete and not of a size to accommodate the refinery operating equipment used today.

An illustration was cited to show the result of handling maintenance work under the above conditions. A refinery charging 80,000 b/d will have some 1200 wage employees of whom 600 will be working on maintenance. The cost of this maintenance labor amounts to $6000 a year per man, and the total cost of maintenance labor to this typical plant including overhead amounts to considerably over $3,000,000 per year. For an 80,000 b/d refinery each day of downtime due to inefficient labor or other cause cuts net income by $60,000 or more.

In contrast, principles were presented to the refiners for the efficient layout and tooling of the maintenance shops, set-up of stores and for the provision of handling and mobile equipment, as based on experience in construction and maintenance in refineries and other industries.

Bring together, into one central area, all the facilities that properly belong together: craft shops, headquarters for field crafts, stores, cleaning facilities, garages and offices. Such centralizing reduces and simplifies handling, improves supervision and avoids duplication.

Put into one building all of the craft shops, all inside stores and the cleaning facilities. Four good reasons exist for housing all these activities in a central building: (1) Initial and maintenance cost is less than for several small buildings; (2) A single building provides greater flexibility to meet new needs; (3) Common use of handling facilities by all activities makes for economy; (4) A central building gives closer coordination among all the activities and promotes co-operation among the crafts.

Provide Machines and Tools

Provide machines wherever possible to do the physical work of men, and provide plenty of small power tools to help a man do all his hand work. This principle applies alike to laborers, helpers, office workers, craftsmen, supervisors, superintendents. For example, a one-hp. motor can do the work of 30 men. For 8 hours of work the motor costs 10c. For the same work the men cost $700.

Tool the operating unit, to provide better handling of equipment and parts, and better access. Items such as column trays, tube bundles, pumps, valves and so on, which have to be handled over and over again at a unit, should be handled by power hoists, gantries, or by mobile equipment such as crane and fork lifts. Platforms, stairways and ladders should be provided to make access easy and to do away with temporary scaffolding.

Trucks, tractors, trailers and all needed mobile equipment should be available to haul men, materials and equipment. There should be well-

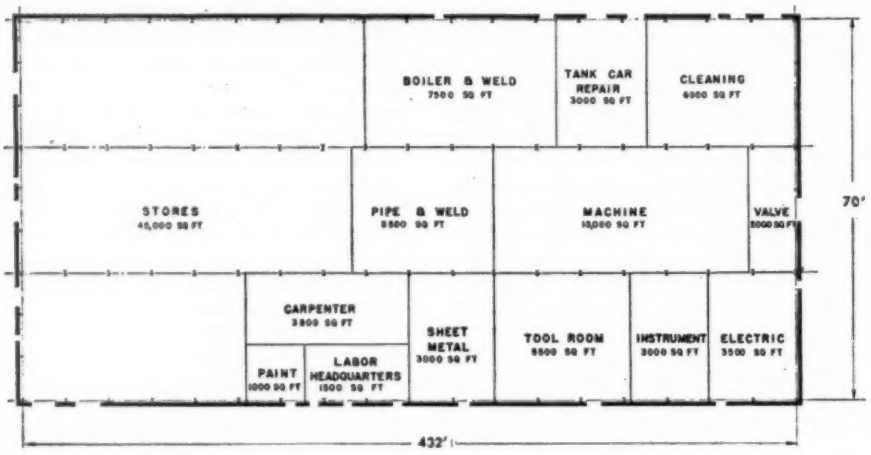


Fig. 1—Suggested arrangement for maintenance shop

built roads to reduce the wear and tear on the mobile equipment.

Above all, flexibility should be provided in the arrangement of the maintenance facilities. New methods, new tools, new processes, changing labor relations, changing work load, and other conditions must be met by re-arrangement of machine tools, by expanding the work areas, enlarging the central building. This is possible only through providing flexibility when the original installations are made.

The flow of work in a maintenance shop is not so easily planned as in a manufacturing shop, but many of the ideas of production line flow can be used in planning a maintenance shop. Machine tools in each shop can be arranged for progressive flow of the normal work coming to the shop. Craft shops that usually work together can be located in the same bay, and adjoining each other. Fig. 1 is a suggested arrangement for the shops.

All of the light shops are in one outside bay of the 3-bay building. In the center bay are several of the heavy shops with the rest of the heavy shops in the remaining outside bay.

One of the jobs of the stores is to deliver material to the shops when needed, where needed and with the least handling. Thus the inside stores used by the heavy shops are located in the same bay as those shops. Stores used in the light shops go in the same bay as those shops. The aisles in the shop area continue straight on through the stores area. Fork lifts and utility trucks use these aisles to make quick deliveries with ease. For heavy items, the bridge cranes can run directly from stores to the shops.

STOPPING REFINERY CORROSION

CORROSION, WHICH COSTS the refining industry a staggering sum each year, came in for its fair share of discussion during API's Midyear Refining Division meeting at Houston. The subjects included destruction and damage from attacks by hydrogen, stress, and stress corrosion of expansion joints in catalytic cracking units, and general protection of ground and underground refinery equipment by cathodic methods.

Hydrogen Blistering

A survey by the corrosion subcommittee to indicate the extent and severity of damage from hydrogen to refinery equipment formed the basis of the paper "Hydrogen Blistering Reported by Several Oil Companies," by M. H. Bartz and C. E. Rawlins, Phillips Petroleum Co., Bartlesville. Of 13 companies contributing information, ten reported blistered steels in their equipment, two had failures, and two said blistering had not been a problem.

There appears general agreement that the blisters develop only in steels which are corroding and releasing nascent hydrogen from action of the corrodent. This new-born hydrogen may combine to form molecular hydrogen, then harmlessly dissolve in the solution or bubble off. Some of this atomic hydrogen, however, will penetrate and diffuse through the corroding steel. If it encounters a break or discontinuity within the solid metal, it collects on this internal surface and one atom combines with another to form molecular hydrogen. In this state the hydrogen is incapable of further diffusion but, as the process continues, the pressure of the trapped gas increases until it becomes great enough to deform and rupture the steel.

Most of the blisters observed in petroleum processing equipment have been traced to massive discontinuities within the steel, these authorities state. Laminations, large inclusions, stringers of small inclusions, phosphorous segregations, and other highly segregated zones are nucleating points for blisters. It is said that even within individual grains "disjunctions" or "rifts," too small for microscopic observation, also may tear open to form blisters or cracks.

The same conditions causing blisters may result in embrittlement, although information available to the authors limits this phenomenon to higher strength steels. Hydrogen embrittlement of low alloy carbon steels in pressure vessels, piping and structural members either has not occurred or is not a serious problem.

Hydrogen embrittlement has been explained on the basis of hydrogen collecting in extremely numerous and small disjunctions within the steel. As the gas collects and metal deformation increases, the metal becomes highly stressed multiaxially. Metal so stressed cannot flow. Consequently a superimposed high stress (such as a blow, or during service) will cause brittle failure.

Acid corrosion releasing atomic hydrogen appears responsible for blistering and embrittlement. Hydrogen sulfide is commonly present in many refining operations and is believed by the authors to be one of the most responsible corrodents; it also may act as a promoter in increasing rate of hydrogen penetration. Cyanides also are suspect as a "promoter."

Controlling Hydrogen Damage

In the opinion of these authorities the most effective way to prevent or control hydrogen blistering or embrittlement would be to control the corrosion. Methods reported as miti-

gating the effects include gunite linings, to keep the corrodent away from the carbon steel shells, installation of alloys resisting corrosion attack, and the use of stainless steel and lead linings. If possible, acid corrodents should be neutralized and hydrogen sulfide removed before the attack commences.

Pointing out that the steel industry can help, the authors declare that the number of massive laminations and large inclusions which nucleate blisters should be reduced by improving the steel. Firebox quality killed steels meeting specifications similar to ASTM A-201 or 212 should offer improvement over the semi-killed or rimmed steels which may be furnished under ASTM Standards A-285, A-283 or A-30.

Hydrogen Embrittlement

A discussion of the operating limits for carbon and alloy steels in contact with hydrogen at high temperatures and pressures was presented by G. A. Nelson, Shell Development Co., San Francisco, in a paper entitled "Hydrogenation-Plant Steels." Many of the important chemicals of today's industrial economy require processing in the presence of hydrogen at high temperatures and pressures—such as hydrogenation of unsaturated polymers, cracked gasolines and light fuel oils; production of ammonia, methanol, edible oils and alcohols. In future, it may be anticipated that greater need for hydrogenation processes may arise: Fischer-Tropsch synthesis of fuels, hydrodesulfurization of crudes and products for sulfur reduction and others.

The damage produced by exposure of steels to hot hydrogen consists of decarburization and intergranular cracking. Even though these cracks are so tiny as to be invisible, except under the microscope, they are so numerous the net effect is a marked deterioration of tensile strength, yield point and ductility. The general condition may be likened to a weak piece of cast iron.

Hydrogen damage at high pressures is attributed to the ability of hydrogen to diffuse into the steel, forming methane by reaction with the iron carbide present. Methane cannot diffuse out of the metal, resulting in the development of high stresses which ultimately lead to cracking at the grain boundaries.

Hydrogen attack is prevented by adding such carbide-stabilizing elements as manganese, molybdenum, chromium, tungsten, vanadium, titanium and columbium. Elements such as nickel and silicon have no effect in preventing interior damage because they do not form carbides. The presence of impurities—i.e., phosphides and sulfides—have a tendency to increase susceptibility to attack.

The effect of hot hydrogen on steels has been extensively reported in the literature, but much of it is based on short-term laboratory investigations. The late war required the oil industry to operate processes making materials never before manufactured in quantity. These brought with them problems regarding materials of construction, corrosion, high-temperature oxidation, erosion and others, along with the strong probability of hydrogen damage. Thus the laboratory-to-practice problem was intensified.

It was realized that short-time tests were not reliable for accurate materials specifications, and there was no time for long-term tests. Consequently, Shell contacted other companies in diverse fields to learn their experiences with hydrogenation units under different conditions than its own plants.

Data from technical papers, other hydrogenation plants and laboratory tests were assembled, along with data from the new plants which had been built. Assembled in chart form, and by means of curves drawn through satisfactory operating points, a clear picture has been obtained of the suitability of various carbon and alloy steels for a particular pressure-temperature combination. The latest set of curves (more than 22 revisions of the charts have been made in the past six years) are presented in the paper, with the explanatory note that it is anticipated further revisions will ultimately be required. These are plotted as temperature vs. the pressure due to gaseous hydrogen alone.

Steel Variations

Variations in the steels as manufactured may have considerable effect on the ability of a particular steel to withstand hydrogen damage. In one case cited, samples from several lines made of schedule 160 steel piping showed considerable differences in this respect (Table 1). The author then warned that, in order to build plants to the upper limit of carbon steel, safe limits should be based on the *average* quality of obtainable steels and, in inspecting a plant for damage, a number of samples should be taken for examination rather than only a few. Emphasis on carbon steel is especially important because, where possible, its use is greatly preferable to the alloy steels by reason of the latter's greater cost.

Hydrogen has been proven capable of diffusing through almost any metal. Experiments in hydrogenation reactors indicate that a complete bond of hydrogen resistant material to a steel is insufficient for protection. It is pointed out, however, that alloy liners can be applied by spot or resistance welding to the shell, drilling "weep" holes through the shell behind each course of liner to permit escape of hydrogen diffusing through the liner. Multi-layered vessels, without bonding of liner to shell, can be used providing weep holes are present in the outer steel layers.

TABLE 1—Effect of Hydrogen on Several Samples of Schedule 160 Piping

Size of Pipe	Wall Thickness (Inches)	Per Cent of Wall Affected
1-in. threaded nipple....	0.280	0.0
1½-in. schedule 160.....	0.400	8.3
2½-in. schedule 160.....	0.555	50.0
6-in. schedule 160	0.848	35.0
6-in. schedule 160	0.873	80.0

The presence of other corrosives complicates the problem. Sulfur, for example, will corrode either carbon or low chromium steels at temperatures above 675° F. The rate rises with the concentration of sulfur and no definite recommendation can be made on the amount of alloy required to resist the attack.

In the case of ammonia, nitriding begins at temperatures above 850° F. and occurs on steels containing more than 2% chromium. For protection against nitriding, an alloy containing 16% Cr, 15% Ni, 3% Si and 0.4% C has been reported satisfactory at 950° F. and 12,000 psi. An alloy containing 57% Ni, 12% Cr and 1.7% tungsten is understood to be satisfactory in converters used in the Claude synthesis of ammonia, with a life between 2000 and 20,000 hours, depending on the quality of the casting.

Cathodic Protection

Cathodic protection of refinery equipment is a logical extension of a corrosion combatting method used extensively in protecting pipelines and underground cables. However, very few refinery installations exist. A report of the successful and economic application of cathodic protection in Shell Oil Co.'s Houston refinery was presented by Derk Holsteyn, entitled "Cathodic Protection Within an Oil Refinery."

The underground network of pipe line systems, storage tanks, processing equipment and structural members forms an intricate arrangement which makes installation of cathodic protection much more complicated than along a pipe line. Also, soil conditions vary widely due to fills, leaks, chemical spills, seepage from sewer and sludge pits; moisture content may show wide seasonal and locational fluctuations. Space for anode installation is limited also and must be designed, along with the protective current source, to assure uni-

form current distribution with minimum cost and operating expense.

Shell's experience, according to Mr. Holsteyn, indicates that negative potentials of 0.85 V., measured to a copper-copper sulfate electrode, will prevent or greatly retard soil corrosion. Currents ranging from 1 to 10 ma. per sq. ft. of exposed surface are required, depending on soil resistance. Copper oxide rectifiers served by the refinery 220 and 440 V. power circuits are used.

At the present time Shell has 43 cathodic units in operation, with more scheduled for installation. The cost per installation has varied from $1700 to $2200, depending on size; annual operating expense has averaged $250, including supervision, repairs and ground-bed renewals. This has reduced the average plant pipe line system maintenance an average of 65 to 75%, based on the 1940-1941 maintenance cost; without it, it is believed maintenance expense might have risen 500% during the ensuing eight years.

Fig. 1 is a cumulative leak record of one area in the Houston refinery before and after installation of cathodic protection. Beginning in 1940, the trend of leak development in the unprotected lines is clearly upward until late in 1941. Shortly after protection commenced the trend leveled off, giving nearly six months without any leaks. In the following four years only one leak was experienced;

In this connection, discussion from the floor brought out that once cathodic protection is initiated after corrosion has already started, a considerable period intervenes before the products of the initial corrosion, which may themselves be corrosive, are "washed out" of the pits and "hot spots" by ionic migration into the soil. Hence the corroded area could easily have been "plugged" and prevented from leaking by the corrosion products. When they are removed later by action of the protective current, the leak develops. Altered services of piping, such as increased pressure, also may cause these pits to leak although actually the line is sufficiently protected.

Anode System

There are various types of anode materials, including such metals as aluminum and magnesium which are used as the source of protective current where cheap electric power is not available. The anode may be made up of salvaged line pipe, cast-iron soil pipe, rails, flywheels, machine blocks or manufactured carbon or graphite rods. To promote an evenly distributed loss of metal over the anode area, usually a clean earth mixed with dissolved chemicals is used as a backfill, or the anode is surrounded with coal-coke breeze. Carbon and carbonaceous materials have an advantage over metallic anodes because the corrosion products are largely gaseous and escape without increasing soil resistance in the immediate area of the anode.

Training of personnel in maintenance requirements and grounding them in fundamentals of the operation is particularly necessary. A number of demonstrations have been developed which show what soil corrosion is, how it operates, and the function of cathodic protection in mitigating its effects. These have been successfully used in training personnel. Maintenance difficulties have been reduced by providing interested parties with standard instructions on construction and maintenance of the installations.

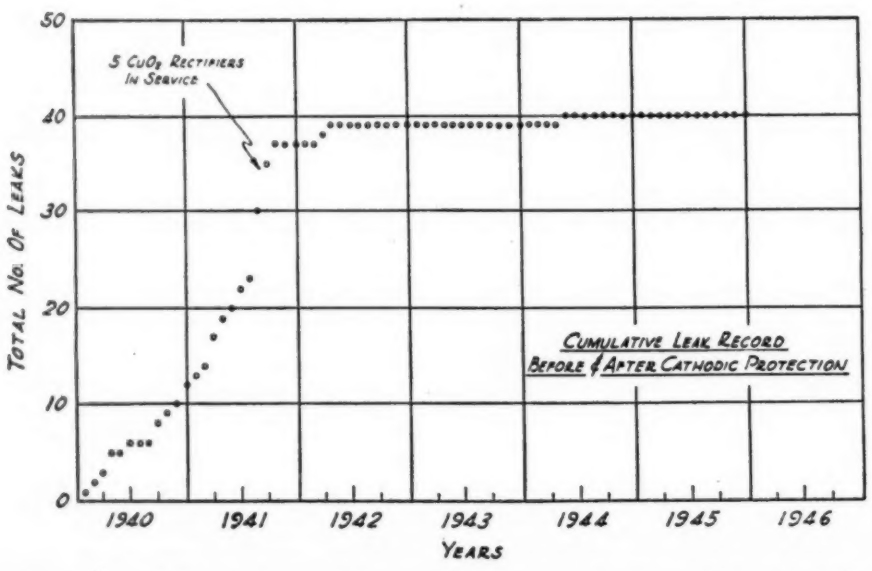


Fig. 1—Cumulative leak record for a refinery area, showing effect of installing cathodic protection

Expansion Joint Corrosion

Numerous failures of bellows-type expansion joints in the large-diameter piping of Fluid catalytic cracking units were experienced during the war, constituting a serious problem in keeping these units running to meet production schedules. The failures, in the bellows, were of three distinct types: (1) erosion, or bypassing the inter protective sleeve, which permitted erosion of the bellows edges; (2) general surface corrosion and pitting of bellows elements, and (3) cracking of bellows elements.

The serious effect on Fluid unit service factors prompted Standard Oil Development Co. to conduct extensive examinations, and the report of this work was presented by H. F. Brown and W. M. Goryl as "Corrosion and Stress Factors in Piping Expansion-Joint Failures."

Several designs differing in the number and contour of elements and methods of welding were involved. All, however, were fabricated of austenitic stainless steel, either AISI No. 304 or 347. In general, the bellows elements were 2.5 to 3 in. wide and about 0.050 in. thick.

Investigation of failed fusion-welded bellows elements indicated either pit- or cell-type corrosion, or by disintegration and cracking of the element. Some cases of intergranular corrosion also were found. The resistance-welded bellows of Type 347 alloy showed failures in the weld, ascribed to design. However, excluding the corrosion failures, the amount of corrosion found did not appear to account for the continued failures unless high stresses also were present. Lengths of joints after use and appearance indicated permanent "set" was occurring—overstressing.

Experimental Tests

An experimental program was initiated of actual testing of these joints under simulated loadings and movements, together with a mathematical analysis to determine magnitude and location of design stresses. An experimental joint was suitably equipped with strain gauges and tested under a double cycle of axial compression and release over the full range of recommended maximum movement. Next, it was compressed until permanent sets were secured. The third test involved strain measurements through the design angle of rotation and the final test was made of the joint under 25 psi. internal pressure while being restrained from axial movements.

From the laboratory investigations, backed up by the mathematical stress analysis, it was concluded that stresses far in excess of the elastic limit of the material occurred when

the expansion joints were subjected to movements within the manufacturers' ratings. It appeared also that the hinged joints were more conservatively designed than the axial expansion type, correlating with service records.

Further consideration of laboratory and mathematical data resulted in the development of a basic design formula which states there is an optimum relationship for disc thickness and width which will permit the maximum movement for a given pressure and allowable stress. Using this formula with stainless steel to resist corrosion, and designing for reasonably low stresses, it is stated that failures of joints can be held to a minimum.

Rapid Methods of Analysis

ONE OF THE MOST IMPORTANT SESSIONS at the 1949 Midyear API Refining Division meeting was devoted to rapid methods of analysis, with a total of 14 papers presented in continuance of the sessions started at the last Annual Meeting.* The papers presented, abstracted below, dealt with microtechniques permitting analyses of extremely small samples, various analyses of cracking catalysts, and determinations of metals and dyes in petroleum products.

Rapid analytical techniques are of special value because they serve the dual purpose of increasing laboratory productivity without requiring more manpower, and permit close following of processing in terms of time. The latter is particularly desirable in detecting off-quality material early during processing.

Microanalytical methods are especially useful in research, where an important sample may be very small, and no more readily available. For example, by methods presented at this session and proved by data correlating with results from conventional procedures, it is possible to determine viscosity and gravity (or density) on less than ten drops of sample, and the equivalent of an ASTM distillation can be performed on little more than a quarter ounce of liquid. Spectrographic methods were extensively discussed also.

"Some Microphysical Apparatus and Methods for Inspection of Petroleum Products," a paper by J. V. Sommer and G. E. C. Wear, Standard Oil Development Co., described three apparatus and procedures developed to enable making, on a microscale, three common inspection tests evaluating petroleum products: density or specific gravity, viscosity, and Engler (ASTM) distillation.

Density is determined by a capillary-pycnometer technique, requiring 0.03 to 0.05 ml. of sample. This procedure may be applied in general to liquid petroleum products, with the exception of those which are extremely volatile or viscous.

The distillation procedure has been developed to give data comparable to those obtained by the ASTM naphtha distillation procedure D-86-46 and the gas oil method D-158-41. Distillation flasks have been designed to accommodate a charge of 3, 5 or 10 ml., depending on the amount of sample available.

Viscosity is determined by means of a thermostatically-controlled inclined capillary-tube viscosimeter; the volume of sample taken is 0.08 ml. The angle of inclination is adjusted to give a suitable efflux time, depending upon the viscosity range of the material being examined.

Spectrographic Methods

"Computing Recorder for Infrared Spectra," a paper by R. W. Foreman and W. Jackson, Jr., The Standard Oil Co. (Ohio), describes a simple electrical instrument which substantially reduces the time required to obtain "percent transmission" from the single-beam type of recording infrared spectrophotometer. This instrument automatically computes the ratio of sample-cell transmission to blank-cell transmission, and permits the conventional potentiometer recorder to plot directly percentage transmission of a sample.

The apparatus is simple and rugged in construction, requiring very little operational dexterity. Savings in computer-time for a spectrum from 2 to 15 microns amounts to approximately four to five man-hours per sample.

The application of ultraviolet measurements to the "Determination of Oil Content in Petroleum Waxes" was presented by W. A. Deitz, S. H. Dole and W. Priestly, Jr., Standard Oil Development Co. Such data correlate very well with results from the conventional procedure for oil content estimations, ASTM D-721-47. It is possible to determine oil content of an 0.5 g. sample to ±0.1% accuracy in an hour or less.

The procedure is applicable over the entire range 0 to 100% oil, whereas the conventional method is not reliable beyond 10%. A separate correlation must be determined for each base stock, however, since the ultraviolet extinction coefficient varies with crude source.

"The Spectrophotometric Determination of Tetramethyldiaminodiphenylmethane in Oils and Greases Using Nitrous Acid," by S. W. Denton, R. M. Oliver and J. T. Wiley, The Texas Co., presents a rapid, simple colorimetric estimation of "methane base" additive in oils and greases, along with data showing accuracy and precision.

The method involves extracting a 200 end-point naphtha solution of the sample with dilute HCl, reacting the extract in appropriate acidity with a small amount of an aqueous solution of sodium nitrite, and determining the transmittancy on an alcohol-water solution of the yellow products at a wave length of 420 millimicrons.

"The Use of a Porous-Cup Electrode in the Spectrographic Analysis of Lubricating Oils," a paper by A. G. Gassmann and W. R. O'Neill, Ethyl Corp., discusses results obtained by spectrographic analysis of lubricating oils for phosphorous, using two different means of introducing sample into the spark. The first method involved quenching white-hot graphite rod electrodes in the oil to be analyzed. This gave satisfactory results when the same base oil was used but did not give desirable results for all oils.

A method then was developed wherein the oil sample contained in a porous graphite cup entered the spark without preheating. The difficulties encountered with quenched electrodes are discussed, the development of the porous cup procedure to minimize these difficulties is described and results obtained by both methods are compared.

A semi-quantitative determination of metallic constituents of gas oils and crudes is described in the paper, "Spectrographic Analysis of Gas Oils and Crudes for Metallic Constituents," presented by M. J. Murray and H. A. Plagge, Universal Oil Products Co. A 100 ml. sample of gas oil, or smaller amount of crude, is ashed in a platinum dish using about 20 mg. of specially prepared pure silica as "ash-aid." A sectored spectrogram of a weighed quantity of the silica-ash mixture is made with the direct current arc.

This is compared with similar spectrograms of synthetic samples in which purified silica is the matrix. Using silica as an internal standard, concentrations measured for the var-

* The previous papers were abstracted in the Nov., 1948 issue of PETROLEUM PROCESSING, pg. 1057 (vol. 3, no. 11).

ious elements in the ash are generally between limits of half and twice true value. This range of accuracy is usually all that is justified when limitations of the sampling and ashing methods are considered, according to these authorities.

"Rapid Analyses by Means of Emission Spectroscopy," a paper presented by H. K. Hughes, J. W. Anderson, R. W. Murphy and J. B. Rather, Jr., Socony Vacuum Laboratories, discusses the experiences of this laboratory in handling a wide variety of analytical problems and details some of the methods used. Almost 3400 samples were processed by the spectroscopy laboratory in 1948, an average of 13 daily. They included used and new oils, deposits, sludges, light products, greases, metals, bearings and miscellaneous materials. Average handling time for 12 samples is about four man-hours.

Progress is being made in developing quantitative analytical procedures; among them determination of the metallic portion of additives in unused detergent-type oils. It is estimated that spectrograph investments in the authors' laboratory are returned twice annually in savings.

Colorimetric Methods

Development work in solvent refining of lubricating oils and, later, plant control was aided by a simple analytical method developed by Anglo-Iranian Oil Co., Ltd., and reported by A. R. Javes, Sunbury-on-Thames, Middlesex, England, in a paper entitled "The Determination of the Furfural Content of Lubricating Oils." This colorimetric method permits semi-skilled operators to determine in five minutes approximate furfural concentrations between 0.0001 and 1.0% and may be altered to suit concentrations outside this range. Some literature methods take 2 to 4 hours.

The method uses filter paper strips soaked with a saturated solution of 2,4-dinitrophenyl-hydrazine in 2N HCl. The test strip is mounted in a calcium chloride tube receiving air bubbled through the oil in a sample bottle. Reference strips for the day's work are made with oils containing known amounts of furfural.

A rapid method for "The Determination of Dyes in Aviation Gasoline" was reported by B. B. Buchanan, J. A. Favre, M. D. Grimes and B. J. Heinrich, Phillips Petroleum Co. It uses a photoelectric colorimeter for the quantitative determination and is suitable for analyzing gasolines containing one or two dye components. For samples containing one dye, transmission is measured with a colorimeter using one filter, corresponding to the absorption peak of the dye. For gasoline containing two dyes, the transmissions are measured using two filters, corresponding to the absorption peaks of both dyes.

With care and strict attention to detail, duplicate results will not differ from the mean by more than 0.1 mg. of dye per gal. of gasoline. Accuracy of the method is approximately 0.1 mg. of dye per gal. of gasoline in the range from 1 to 10 mg. per gal.

Metallic impurities in petroleum oils can contaminate and considerably reduce the efficiency of common catalysts used in refinery operations, even though present in minor amounts. J. H. Karchmer, Humble Oil & Refining Co., describes a method for "Colorimetric Determination of Vanadium and Titanium in Petroleum Ashes," using a filter-type instrument which determines the intensity of the orange-brown color of the vanadium-peroxide complex. This results when the water-soluble portion of a mixed carbonate fusion is treated with an excess of sulfuric acid and then with hydrogen peroxide.

Titanium is likewise determined by treating a pyrosulfate fusion. The method is capable of detecting 0.05 mg. of vanadium and 0.02 mg. titanium with an accuracy of ±10% and reproducibility of ±7% for vanadium and ±5% for titanium.

"Determination of Free and Combined Iron in Cracking Catalysts," by R. E. Snyder and R. O. Clark, Gulf Research & Development Co., describes a method based on the sensitive colorimetric reaction between orthophenanthroline and ferrous iron for quantitatively determining the free and combined element. The build-up of iron is of considerable interest in the study of catalytic cracking.

For total iron the catalyst is digested with hot HCl or fused with potassium bisulfate. For free iron it is treated with neutral copper sulfate solution and the excess copper removed by displacement with aluminum. Hydroxylamine hydrochloride is added, the pH adjusted with an acetate buffer, and the ferrous phenanthroline-colored complex is developed.

Applicability of the methods is illustrated by comparing data with known samples and on samples from a cracking unit. Reliability of data is presented from the standpoint of diverse ions and compounds.

Combustion Methods

Adaptation of an existing method as a tool for following behavior of cracking catalysts is presented in the paper by George E. Schmitkons, Standard Oil Co. (Indiana), entitled "Determination of Carbon on Cracking Catalyst by the Leco Method". In the "Leco" method, the quantity of carbon dioxide evolved in combustion of coke on the catalyst is determined volumetrically with a special burette which permits reading the volume of caustic-soluble gas as percent carbon in sample. The method is used extensively in carbon-in-steel determinations.

As modified for determination of carbon on catalyst, the method now is being used for research and routine plant-control in catalytic cracking in Standard's Whiting plant, where it has proved capable of high precision and accuracy, together with shorter elapsed time when compared with conventional gravimetric procedures. In adapting the method, much has been learned about techniques for complete and rapid combustion of carbon from catalyst without entrapping significant amounts of carbon in the pores of the catalyst. The analyst can follow readily the progress of combustion.

Controlling the vaporization rate of liquid samples during the conventional combustion analysis frequently is a troublesome problem, particularly when liquids of widely differing volatility are encountered. Although lack of control ordinarily manifests itself as errors resulting from incomplete combustion, often it is also the cause of damaging explosions occasioned by too-rich mixtures.

The method described by W. S. Young, The Atlantic Refining Co., "Combustion Analysis of Liquid Materials," largely avoids these difficulties and is applicable to the combustion of liquids in determining elementary composition. For this purpose it has the advantages of simplicity, speed, ease of control, accommodation of a wide volatility range and relative safety over the ordinary method.

Briefly it involves feeding liquid sample from a weighed vessel through a fine capillary tube into a combustion-tube zone sufficiently hot to cause immediate vaporization and consumption of the small droplets issuing from the tube end. Flow of combustion products proceeds from the point in the usual fashion through conventional catalytic and purifying zones in the combustion tube.

At present the method has been applied to carbon, hydrogen, sulfur and halogen determinations with reproducibility satisfactory for routine purposes. Under ideal conditions one operator can finish between 15 and 20 analyses per 8-hour day.

A method presented by I. W. Mills, Sun Oil Co., entitled "Rapid Determination of Aromatics in Oil Fractions," gives accurate and reproducible results in determining aromatics in viscous oil fractions. It is based on the ability of silica gel to absorb aromatics selectively in the presence of paraffins and naphthenes, and it is applicable to samples having initial boiling points above 550° F. Accuracy is within 1% as established by analyses of known mixtures.

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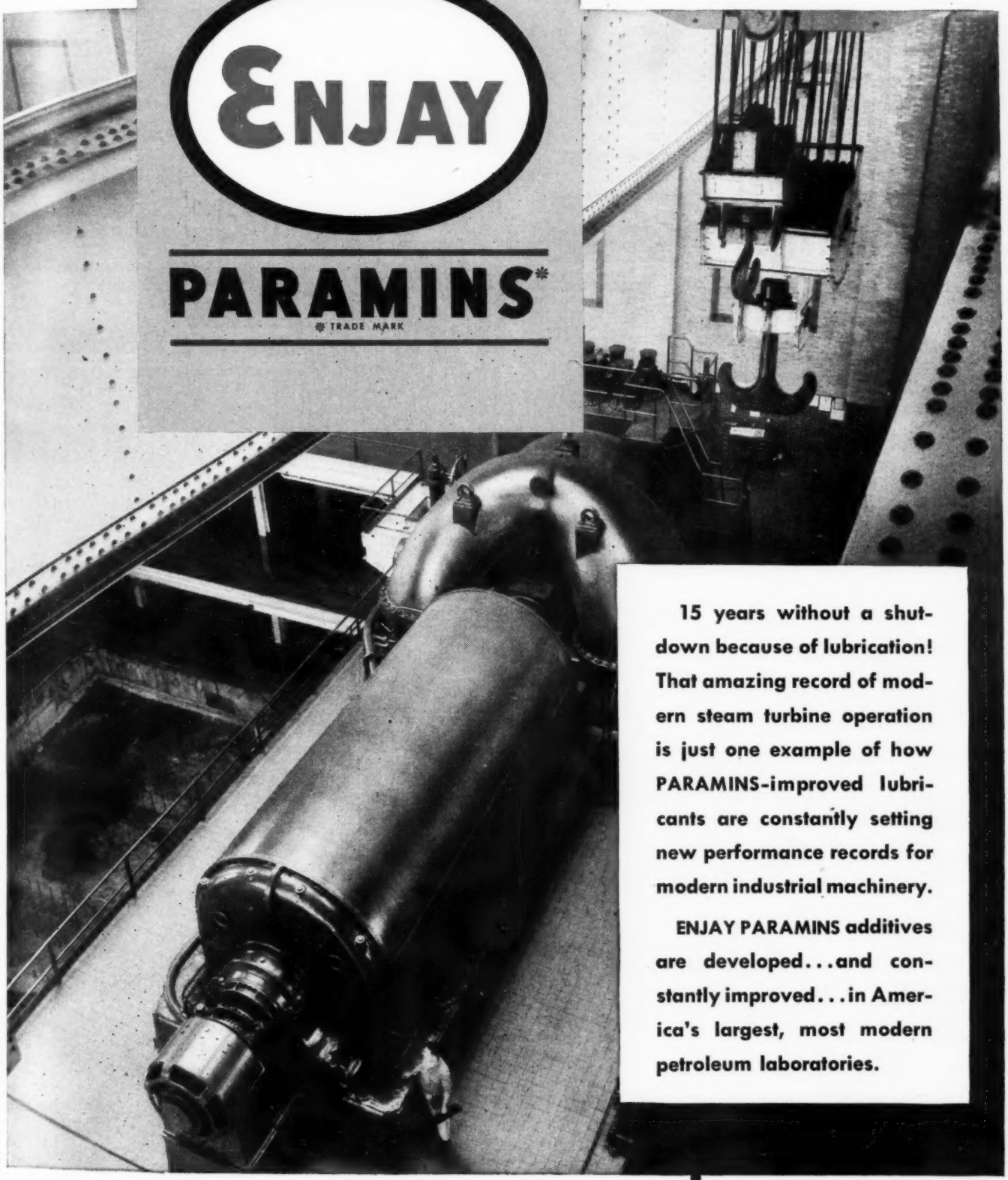

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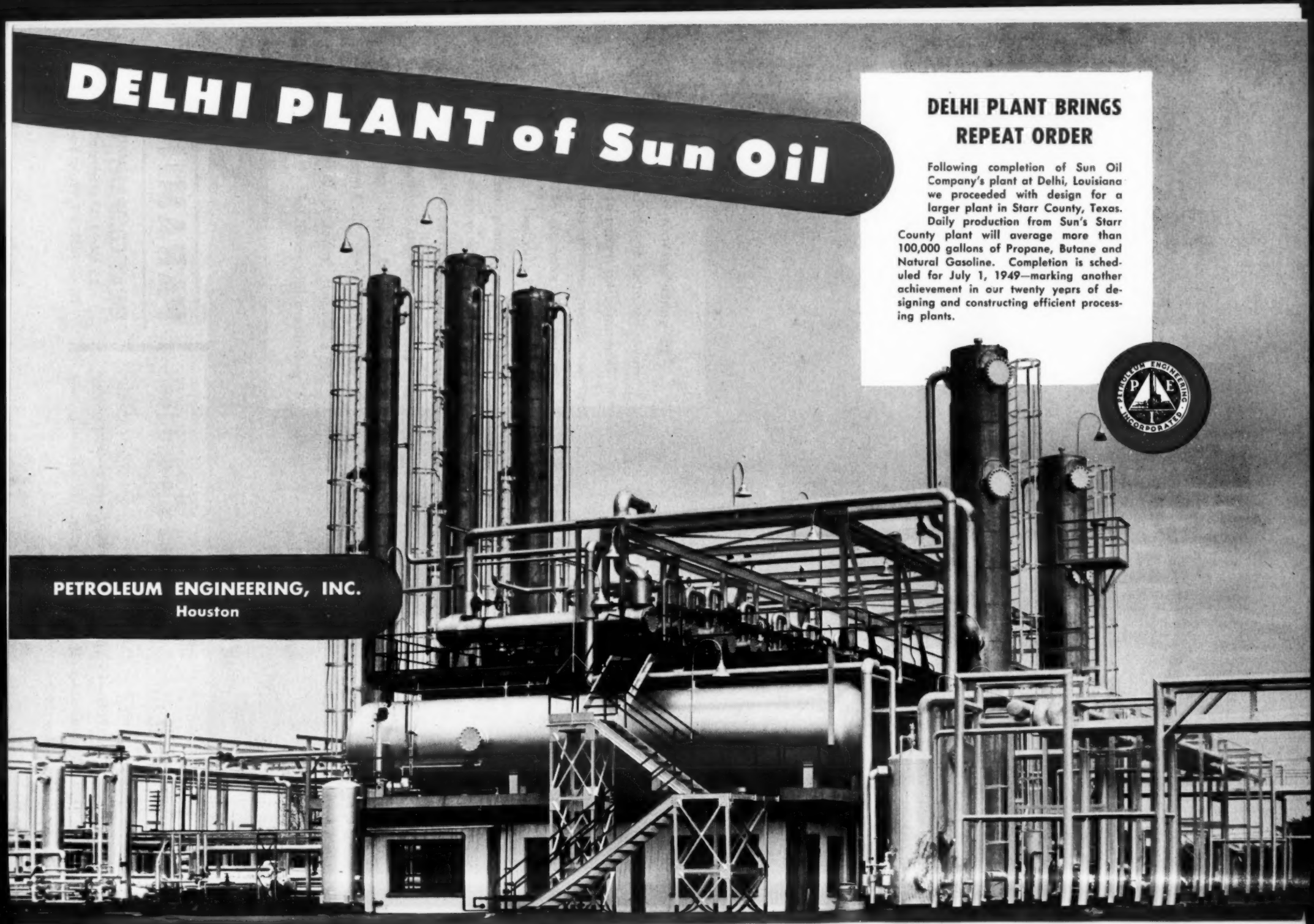
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PETROLEUM SULFUR PROBLEMS

Two-Day Symposium of ACS Petroleum Division Focuses Attention on Identification and Removal of Sulfur Compounds

By B. H. WEIL*
Special Petroleum Processing Writer

REMOVAL of excess sulfur from petroleum and its products is a problem of greater importance to the refiner today than ever before.

In an effort to shed some light on the problem—its causes and cures—members of the American Chemical Society's Division of Petroleum Chemistry held a two-day "Symposium on Organic Sulfur Compounds as Related to Petroleum" in San Francisco Mar. 30 and 31 during the 115th National ACS Meeting. Chairman was Dr. A. A. O'Kelly, associate director of Socony-Vacuum's Research and Development Dept.

Papers presented covered:

1) Sulfur removal processes, including hydro-desulfurization, catalytic desulfurization, and solvent extraction.

2) Sulfur content of various types of gasoline.

3) Effects of sulfur in petroleum fractions.

4) Uses for petroleum sulfur.

5) Properties and reactions of sulfur compounds.

As was stressed many times during the sessions, the presence of sulfur compounds in petroleum crudes and fractions poses problems of (1) equipment, pipeline, and storage corrosion; (2) consumer acceptance as regards odor; (3) octane number depression (caused by such types as mercaptans, disulfides, and polysulfides); (4) diminished lead susceptibility; (5) inferior product stability; (6) poorer combustion characteristics; etc. All of these problems have recently been intensified by the need for increased use of high-sulfur crudes, such as those from West Texas fields, and by radical changes in petroleum cracking processes—the content and nature of sulfur compounds vary widely between straight run, thermally cracked, and catalytically cracked products.

In the past, when low-sulfur crudes were extensively employed, "sweetening" usually sufficed, although several processes for mercaptan removal were successfully developed and employed. Even the latter methods, however, are often inadequate today, since they usually fail to remove disulfides and other sulfur compounds from high-sulfur fractions. Doctor sweetening — once the universal method—has actually been found detrimental to lead susceptibility and storage stability, and effective only for its original purpose, odor removal.

Refiners, naturally, are searching diligently for economic methods of removing excess sulfur—preferably at the well or refinery gate, in order to do away with much product desulfurization and treating. To date, however, only two general desulfurization methods are known which come anywhere near solving this problem—sulfuric acid treating and destructive hydrogenation. The reagent in the first case, however, is also far too fond of unsaturated and aromatic hydrocarbons, while destructive hydrogenation (or even less - strenuous hydrodesulfurization) usually requires expensive equipment and involves high operating costs.

Moreover, despite all of the past research on petroleum sulfur compounds and their removal, far too little is known about their exact constitution and physical and chemical properties—information vital to successful development of better refining methods.

Hydrodesulfurization

As Dr. E. Emmet Reid, professor emeritus of Johns Hopkins, pointed out in his introduction to the symposium, destructive hydrogenation eliminates 100% of all sulfur compounds from light distillates and, under certain conditions, 80-90% of these compounds from heavy fractions. No papers on destructive hydrogenation were presented, but numerous papers discussed related phases of less strenuous hydrodesulfurization.

According to E. C. Hughes, H. M. Stine, and R. B. Faris of Standard Oil Co. (Ohio) the sulfur contents of high-sulfur heavy petroleum oils, such as gas oils and reduced crudes, can be reduced to those of corresponding low-sulfur oils by hydrodesulfurization over a cobalt oxide-molybdenum oxide-aluminum oxide catalyst at 750° F., 1000 cu. ft. of hydrogen per barrel of hydrocarbon, and a pressure of 300 psi. Mild operating conditions and low hydrogen circulation rates were possible because complete sulfur removal was not attempted; final treatment can then be carried out in the same manner as on lower-sulfur crudes and products. Entire crudes can thus be processed instead of gas oils or reduced crudes, but at more expense and with more rapid catalyst deterioration.

Alexis Voorhies, Jr., and W. M. Smith of Esso Laboratories reported that catalytic hydrogenation at 750 psi. improves the quality of high-sulfur refractory catalytically cracked cycle stocks to the point where they are at least as desirable as cracking stocks as the original virgin gas oils, at the same time effecting virtually complete sulfur removal, maintaining catalyst activity, and obtaining 100% volume yields. Previous work had involved the use of sulfur-resistant catalysts at 3000 psi.; while the latter method yields superior cracking stocks, the low-pressure method is adequate for the production of gasolines which meet sulfur specifications without further treating, and the hydrogenates are at least equal in quality to the corresponding virgin gas oils as regards gasoline yields, etc.

During the recent war, Shell Oil Co. employed hydrodesulfurization of gasoline fractions on a large scale to augment supplies of aviation gasoline by rendering suitable high-aromatic fractions which had high sulfur and olefin contents. According to Robert M. Cole and D. D. David-

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son of Shell Development Co., the process utilized a commercial tungsten-nickel sulfide catalyst and operated at 50-75 atmospheres pressure, liquid hourly space velocities of 5-10, temperatures between 450-800° F., and a mole ratio of hydrogen to liquid feed of about 7 to 1. Sulfur retention was found to be independent of sulfur content of the feed for a given set of operating conditions. While thermally cracked gasolines did not generally contain sufficient aromatics for production of high-quality aviation blending stocks, partial desulfurization, especially of lower boiling fractions, proved practical for motor gasoline production, yielding small increases in both clear and leaded octane numbers.

Hydrodesulfurization may be effectively accomplished by hydroforming operations, according to B. Spurlock and J. E. Muth of the California Research Corporation. As Dr. E. E. Reid points out, however, such processes are too expensive for use for desulfurization alone. In the work reported by Spurlock and Muth, vanadia-alumina and molybdena-alumina co-precipitated catalysts both proved excellent. The vanadium catalyst has the poorer thermal stability (indicating shorter life) but was the better for feed stocks of very high sulfur content, on the basis of higher gasoline yields and much lower coke production. The molybdenum catalyst was much more versatile, however, in that its activity was unaffected by the sulfur content of the feed stock.

In a paper presented before the general session of the Division of Petroleum Chemistry, Vladimir N. Ipatieff, George S. Monroe, and Raymond E. Schaad of Universal Oil Products summarized some of their extensive research on the treatment of California cracked gasoline with hydrogen at temperatures of 325-500° C. and pressures of 7-20 atmospheres over nickel molybdate catalysts (as such or supported on various materials). Such treatment resulted in removal of from 60 to 80% or more of the organic sulfur compounds contained therein, largely eliminated as hydrogen sulfide. Gum content of the gasoline was lowered, and color and color stability were improved, but bromine number and octane number were also lowered (the latter by 4-8 numbers), necessitating catalytic reforming for restoration of the octane number to that of the original sour gasoline.

Catalytic Desulfurization

Higher yields (4.2 bbls./100 bbls. charged) of higher octane gasolines (gains of 6.8 ASTM clear motor octane numbers) combined with increased yields of gas oil (6.0 bbls./100 bbls. charged) are added benefits from the catalytic desulfurization of Slaughter crude oil over bauxite, according to Bureau of Mines experiments reported by J. H. Hale, M. C. Simmonds, and F. P. Whisenhunt. Desulfurization percentages ranging from 20-55% were obtained by varying operating temperatures from 450-850° F. and holding other conditions constant. When operating at 750° F., sulfur contents decreased from 50-58% when liquid hourly space velocities were varied from 1.00-0.10. The gasoline obtained has a higher antiknock value because of reduced sulfur content and increased olefin and aromatic content. Operations employing hydrogen and an operating pressure of 225 psi. over cobalt-molybdate-bauxite and zinc-molybdate-bauxite catalysts showed these catalysts to be superior to bauxite for both desulfurization and reforming of residual material.

As pointed out by W. P. Ballard, N. A. Merritt, and J. C. D. Oosterhout of The Texas Co., the vapor phase clay desulfurization of naphthas is a well known process for improving clear octane number and lead susceptibility. Recently, however, some plants have found that it would be very desirable to be able to reduce the sulfur contents of middle distillates of the kerosene boiling range by a similar treatment over fuller's earth. The tests conducted employed temperatures ranging from 600-900° F., space velocities from 0.5-12.5 v./hour/v., catalyst ages up to 2000 bbls. per ton, and charge stocks of various sulfur contents. It was found that high sulfur middle distillates could be desulfurized effectively by vapor phase processing over such clays as No. 1 Riverside Earth at 750° F. and 1.0 v./hour/v., then following this step by rerunning for color improvement.

Solvent Extraction

In his introductory remarks, Dr. Reid declared that research to date on methods of removing sulfur compounds by solvent extraction has not yielded commercially successful methods. Some of his latter statements also bear on such processes, for he pointed out that a sulfur content of 2% would correspond to 6.4% thiophene or 7% of a dimethyl thiophene, while a 5% sulfur crude in which the sulfur compounds have an average molecular weight of 320 (about C_{20}) would have 50% of its hydrocarbons bound to sulfur. Such extraction losses, obviously, would be highly uneconomic, indicating that simple extraction (without chemical breakdown) is not the answer for high-sulfur heavy stocks.

Two systematic studies of the action of anhydrous hydrogen fluoride toward individual sulfur compounds in hydrocarbon solutions were reported in independent papers, the first by A. P. Lien, D. A. McCauley, and B. L. Evering of Standard Oil Co. (Ind.) and the second by R. E. Barieau and M. R. Barusch of California Research Corp.

According to the first authors, "the extraction of individual organic sulfur compounds with anhydrous liquid hydrogen fluoride shows an orderly progression with changes in sulfur type, in molecular weight, or in configuration of substituent groups. Increased extraction is obtained going from mercaptans to disulfides to thio ethers, but extraction is decreased with increasing molecular weight of a given type of sulfur compound. Whereas transition from primary to secondary to tertiary alkyl substituents result in progressively increased extraction, introduction of the phenyl group markedly lowers extraction. . . . Besides extraction, certain sulfur compounds undergo intra- and intermolecular reactions in the presence of hydrogen fluoride. Addition of olefins to mercaptans results in the formation of thio ethers soluble in hydrogen fluoride and thereby markedly enhances the degree of extraction."

Barieau and Barusch found that the sulfur compounds with which they experimented "may be divided into three groups with regard to the selectivity of hydrofluoric acid for their removal: (1) small or no selectivity—elementary sulfur and dibenzothiophene; (2) medium selectivity—carbonyl sulfides, disulfides, and mercaptans, with mercaptan selectivity somewhat greater than disulfide selectivity; (3) large selectivity—sulfides and alkylthiophenes."

A discussion of the alkyl phenols as solutizers in the Shell Solutizer and Tannin Solutizer processes for removal of mercaptans from gasolines was presented by A. C. Nixon and H. E. Randlett of Shell Development Co., with special reference to the factors affecting the natural occurrence in gasoline fractions of alkyl phenols, their effect on gasoline properties, and their physical properties (including those of their alkaline solutions).

Sulfur Content of Gasolines

The total sulfur content of gasolines, depending upon their sources, varies approximately from 0.01-0.5% for straight run gasolines, from 0.02-1.5% for thermally cracked gasolines, and from 0.01-0.3% for catalytically cracked gasolines, and is practically zero for hydroformed and hydrogenated gasolines, according to Dr. Reid. The sulfur compounds in straight run gasolines were said to comprise mostly aliphatic sulfides and mercaptans (butyl-hexyl predominating among the latter). Small proportions of disulfides are contained in such gasolines, but thiophenes are usually

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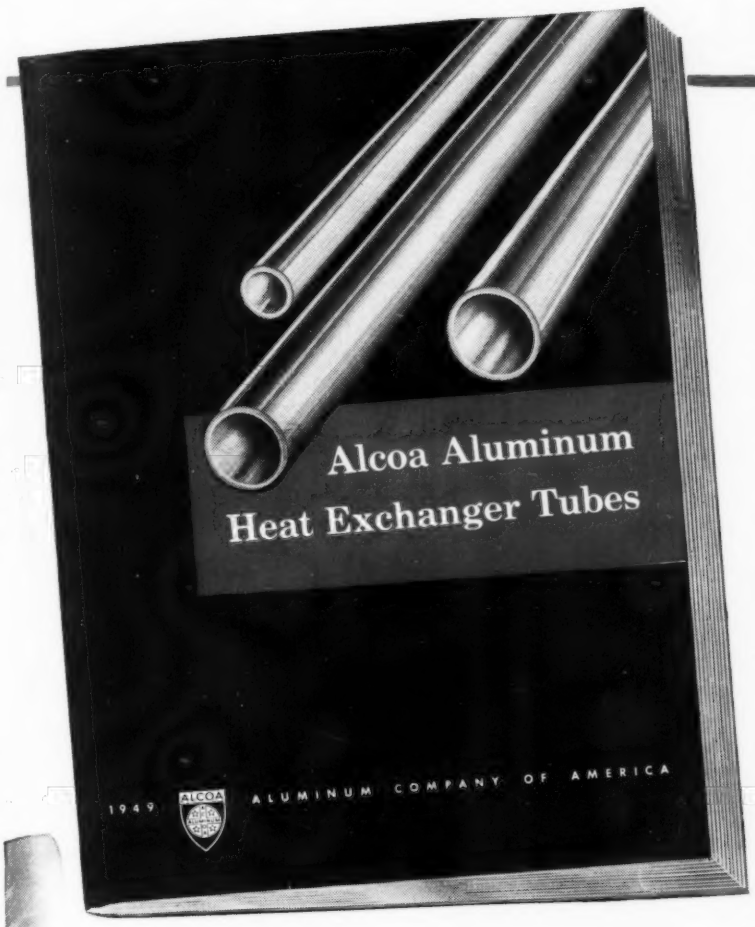

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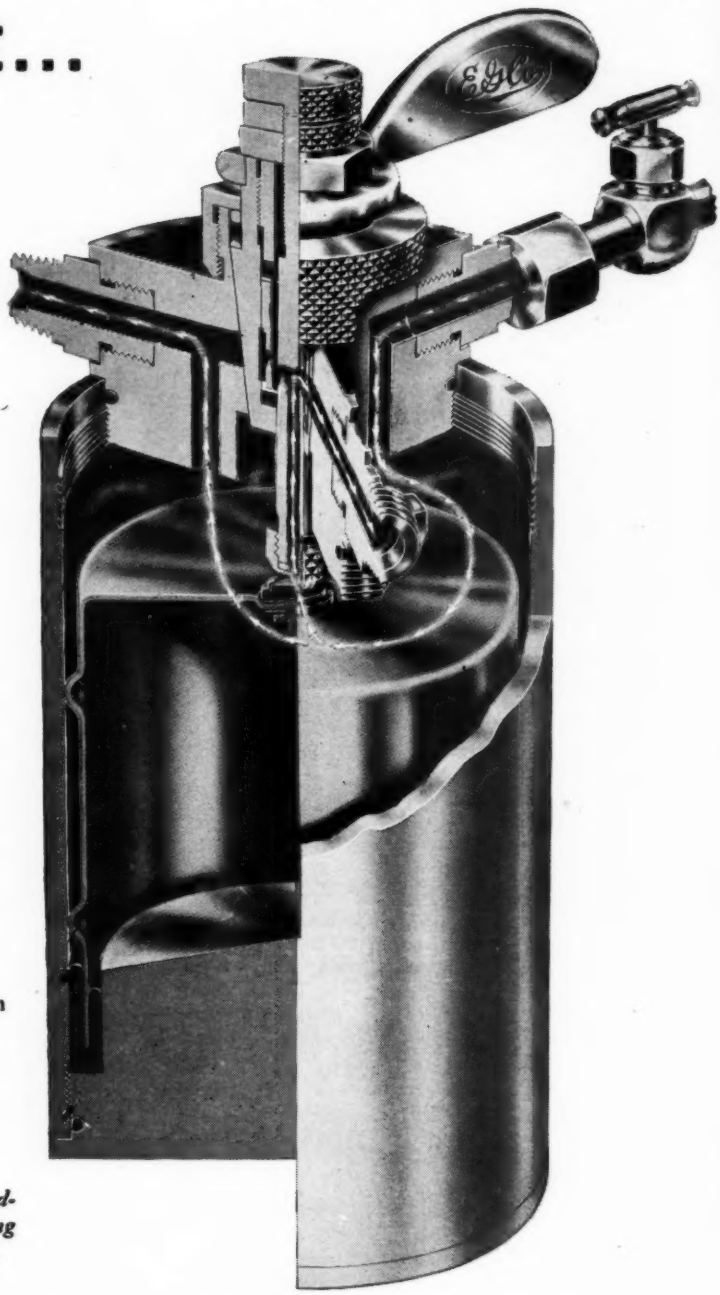

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absent, except in certain California crudes.

Thermally cracked gasolines, according to Dr. Reid, are poor in aliphatic substituents but rich in mercaptans (chiefly of low molecular weight) and thiophenes. Catalytically cracked gasolines were said to be almost mercaptan free but to contain chiefly sulfur compounds of the thiophene series (the type most stable in the presence of catalysts, and by far the most difficult to remove).

As may be noted above, catalytic cracking has a marked desulfurizing effect as compared with thermal cracking; in conventional fluid catalytic cracking, for example, M. J. Sterba of Universal Oil Products reports that "about 50% of the sulfur in the feed stock appears as hydrogen sulfide in the process gas and only 5% appears as sulfur in the gasoline." Of those sulfur compounds which do appear in the cracked products, Sterba states that relatively high concentrations appear in the fraction boiling just below and somewhat above 400° F., so that increasing the end point of catalytic gasolines much above 400° F. is likely to be accompanied by an abrupt increase in their sulfur contents. Low gasoline sulfur contents are favored by low reactor temperatures and high conversions.

J. M. Barron, A. R. Vander Ploeg, and H. McReynolds of The Texas Co. presented a paper on the sulfur distribution in thermal cracking of high-sulfur feed stocks. The ratio of sulfur in the gasoline to sulfur in the charge varied from 0.08-0.18 for most of the crude sources considered, with a value of 0.34 for California crude. The sulfur concentrates in the bottoms fraction, whose sulfur content in each case was greater than in the charge stock.

Effects of Sulfur

As mentioned earlier, sulfur compounds in petroleum fractions are known to cause corrosion, lower octane numbers and lead susceptibility, instability, poorer combustion characteristics, and other undesirable properties. Three phases of this subject were discussed in this symposium.

H. K. Livingston, J. L. Hyde, and M. H. Campbell of E. I. du Pont de Nemours and Co., pointed out that sulfur compounds in gasoline directly or indirectly combine with lead in its active antiknock form to produce lead reaction products of reduced antiknock activity. While tetraethyl lead itself serves to minimize SO_3 formation and subsequent corrosion, analyses of engine deposits show that lead oxysulfate is the major constituent of engine deposits from leaded high-sulfur gasolines.

According to R. B. Thompson, L. W. Druge, and J. A. Chenicek of Universal Oil Products high-sulfur and doctor-sweetened fuel oils have been found to have poor storage stability. The sludges which formed upon storage proved to have much larger sulfur percentages than the oils in which they arose. Investigations showed that free sulfur, disulfides, and polysulfides promote sludge formation, while thiophenes, aliphatic mercaptans, and aliphatic sulfides show little harmful effects. Doctor sweetening, which intensifies the percentage of the former compounds, thus increases instability and sludge formation; the authors recommend the use of such treatments as caustic methanol extraction, which removes mercaptans (hence undesirable odor) without increasing the disulfide and polysulfide contents.

Indirect Effects on Catalysts

As pointed out by G. A. Mills of Houdry Process Corp., the efficient performance of cracking catalysts is vital to successful operations. While it has been found that the factors "important in catalyst aging are the chemical nature of the atmosphere to which a catalyst is exposed, the time and temperature of this exposure, and the type of catalyst," it has also been noted that "abnormal aging" sometimes occurs; i.e., the catalyst loses selectivity, the ability to produce gasoline relative to coke and gas. This has been found attributable to the presence in the catalyst of heavy metals which either accumulate therein by entrainment from certain petroleum stocks or, in the case of commercial clay catalyst (but not synthetic), are constituents thereof. Iron in such catalyst, for example, is brought into catalytically active state through reaction with the sulfur compounds contained in catalytic cracking charge stocks, thereby causing the catalyst to lose selectivity.

Uses of Petroleum Sulfur

The existence of sulfur compounds in petroleum stocks and the frequent necessity for their removal is not always an unadulterated evil, as pointed out by three papers in this symposium which dealt with the commercial uses of the sulfur compounds recovered.

Two of these papers were presented by L. Kermit Herndon of Ohio State University and were concerned with "Recovery of Elemental Sulfur from Refinery and Natural Gases" and "Treatment of Refinery Acid Sludges to Recover Elemental Sulfur and Coke"; both covered research conducted for the Southern Acid and Sulfur Co. This company has built two commercial plants (110 and 60 long tons per day, respectively) to produce sulfur from high-sulfur hydrocarbon gases by scrubbing out the hydrogen sulfide and converting it by partial oxidation to sulfur, with sulfur recoveries in the range of 90-96%.

As regards utilization of acid sludges, Herndon pointed out that three main problems had to be considered before a commercial plant (now in the design stage) could be planned: (1) corrosion, (2) sludge decomposition, and (3) purification. In the process developed, refinery sludges are coked at elevated temperatures, yielding a substantially sulfur-free coke and gases containing sulfur dioxide, water vapor, combustion products, and hydrocarbons. To avoid excessive purification, the sulfur dioxide content is reduced to elemental sulfur by means of hydrogen sulfide or hydrocarbons. The sulfur is scrubbed from the gases and may then be used for sulfuric acid manufacture in the usual manner.

According to A. E. Bearse, D. R. Myers, and R. S. Shutt of Battelle Memorial Institute, the mercaptans and other sulfur compounds available from such petroleum desulfurization processes as the Unisol and Solutizer methods have potentialities considerably in excess of their value as fuels. One use on which the authors have conducted research is the synthesis of sulfonium bases, prepared from mercaptans via synthesis of alkyl sulfides, reaction of the latter with alkyl sulfates, hydrolysis of the resultant sulfonium alkyl sulfate, and treatment of the resultant product with barium hydroxide. Sulfonium bases have potentially important uses " in the fields of adhesives, synthetic resins, cellulose fibers, cellulose ethers, and surface-active agents."

Properties and Reactions

Fully half of the symposium was devoted to consideration of the properties of the sulfur compounds contained in petroleum fractions. As was stated many times, present knowledge of the identity of all these compounds and their physical properties and reactions is all too scanty, yet this information is vital to the successful development of methods for their removal.

As Dr. Reid pointed out, petroleum fractions contain many different types of sulfur compounds—mercaptans, disulfides, sulfides, cyclic aliphatic sulfides, aromatic sulfides, etc. In addition, it seems certain that high-boiling distillates and residuals contain other and as-yet-unknown sulfur compounds. Resinous and asphaltic materials contain sulfur as well as oxygen; as a result, heavy asphaltic crudes are usually rich in sulfur. New techniques for identifying and separating all these

sulfur compounds and more information on their reactions seem vital.

For example, Dr. Reid pointed to thiophene and its alkyl derivatives, for whose removal from petroleum fractions "no good and commercially sound way has been found" other than sulfuric acid extraction or destructive hydrogenation. Thiophenes not only survive cracking but are actually synthesized thereby from other sulfur compounds. Their removal from shale oil gasoline will pose an acute problem, since the sulfur content therein may approximate 1%, all of it thiophenic. Present great activity in thiophene chemistry is therefore quite understandable.

The need for fundamental information has been thoroughly recognized by the petroleum industry. API Research Project 48, established in 1948, was set up to study "the production and purification of sulfur compounds, measurement of their physical and thermodynamic properties, identification and measurement of sulfur compounds in crude oils, and development of methods of synthesis and identification." According to W. D. Seyfried of Humble Oil and Refining Co., who presented a detailed description of the plans and organization of this project and accomplishments to date, work on the first three phases of the project is being conducted at the Bureau of Mines, with the fourth phase under study at Northwestern University.

Further details of the first phase of the API research project were presented by William E. Haines, R. Vernon Helm, Welton J. Wenger, and John S. Ball of the Bureau of Mines. As pointed out, many factors are involved in the preparation and purification of such sulfur compounds as the thiols, sulfides, disulfides, and thiophenes.

Gordon M. Barrow and Kenneth S. Pitzer of the University of California discussed existing data on the thermodynamic properties of sulfur compounds and pointed to the need for additional thermochemical data with respect to organic sulfur compounds. The occurrence and preparation of unsymmetrical sulfides were described by Jack B. Maticka, William E. Haines, and John S. Ball of the Bureau of Mines.

Study of Thiophenes

A detailed paper on "The Thiophenes: Their Synthesis, Chemistry, and Methods of Removal from Coal Tar and Petroleum Stocks" was prepared by Howard D. Hartough and Darwin E. Badertscher of the Socony-Vacuum Laboratories and presented by Bert Folda. Some 136 references were cited by the authors in their written paper; after referring to 81 different studies on thiophene removal, they agreed with the previously cited remark of Dr. Reid that the 60-year-old method of sulfuric acid washing is still one of the best of the known ways to remove thiophenes.

Other significant papers dealing with sulfur were presented at the meeting, but space limitations prevent review of them at this time.

In the keynote words of Dr. E. Emmet Reid, "By concentrating new knowledge and new diagnostic methods we should be able to get a better knowledge of the sulfur compounds that are present (in petroleum and its fractions) and then devise some more practical methods of eliminating them." It was for this purpose that the ACS Division of Petroleum Chemistry held the symposium reported in this article, a symposium which, while of considerable scope in itself, serves also to point to the great need for additional knowledge, hence additional research. This entire subject is of great and growing importance to the entire petroleum industry.

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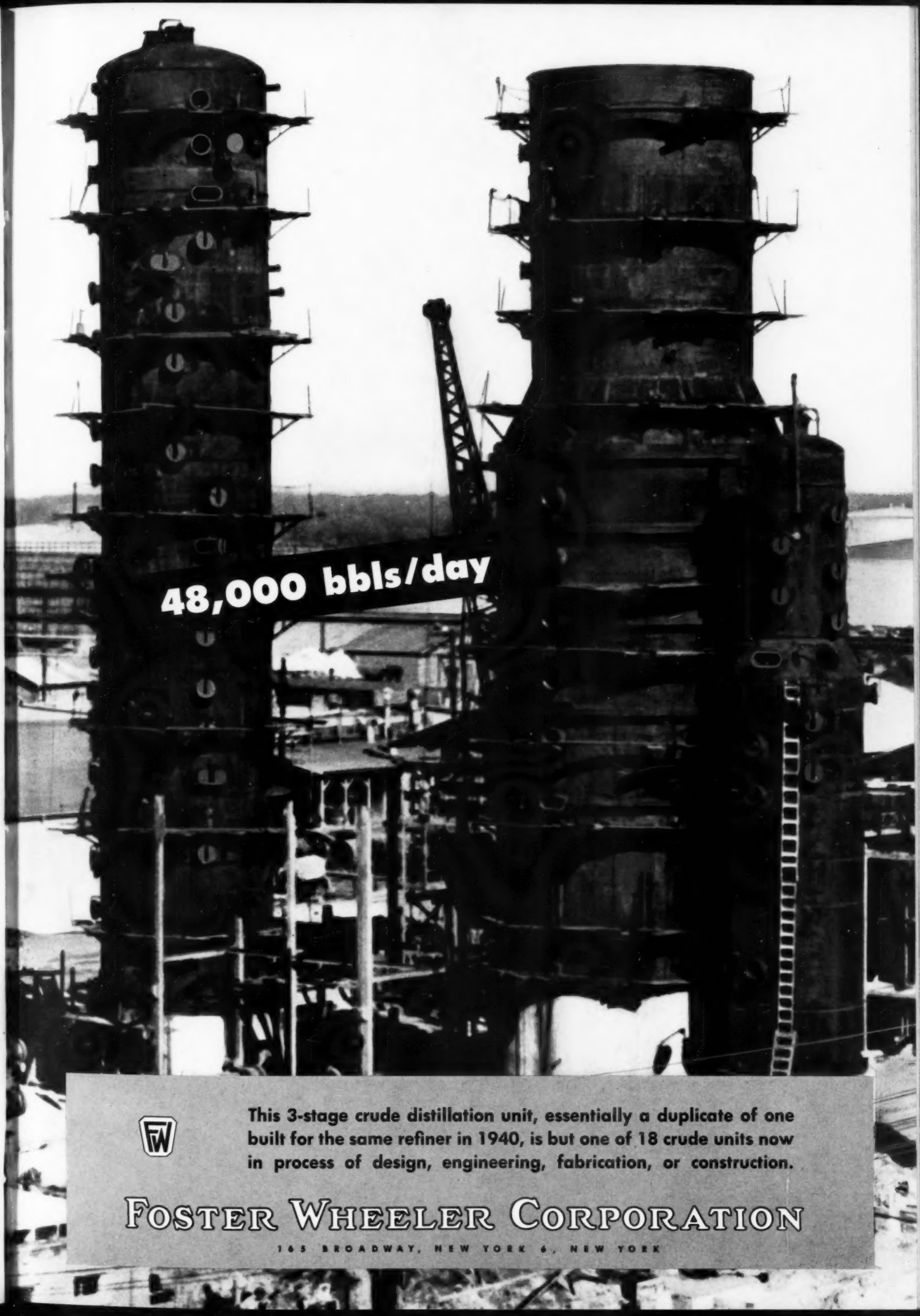

This 3-stage crude distillation unit, essentially a duplicate of one built for the same refiner in 1940, is but one of 18 crude units now in process of design, engineering, fabrication, or construction.

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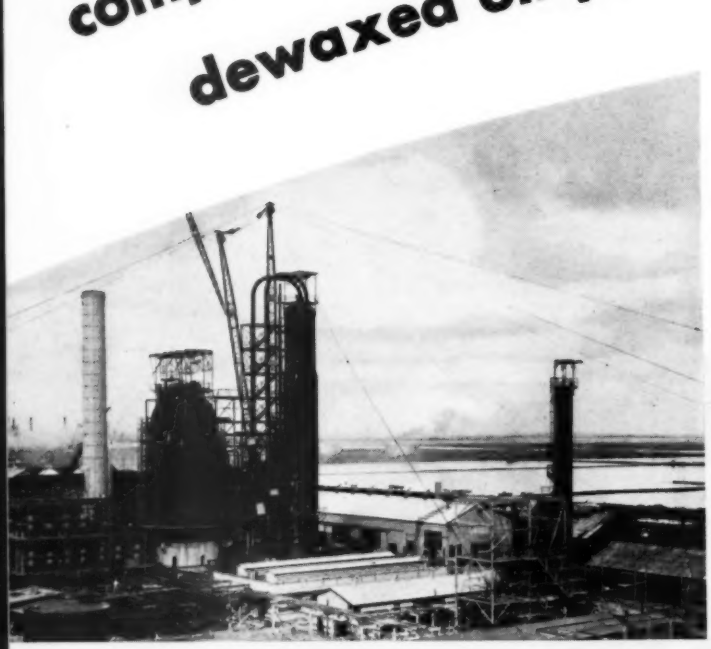

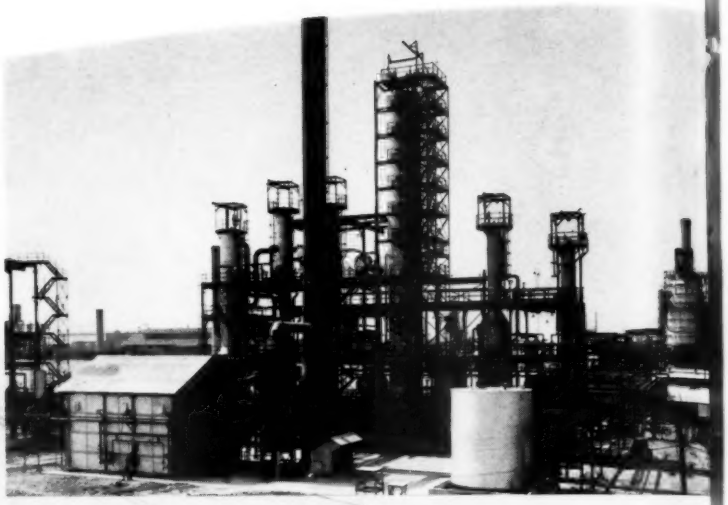

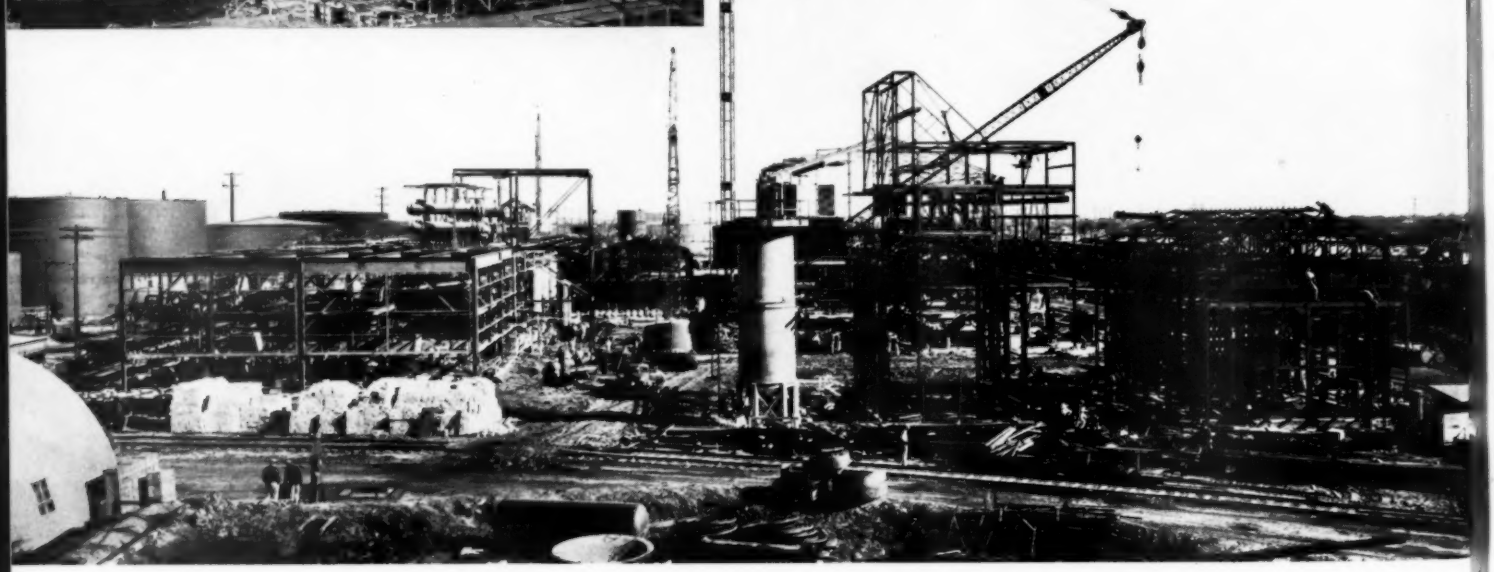

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On this and the following pages are presented staff-written reports of some of the more important and interesting papers presented at the recent 37th Annual Meeting of the Western Petroleum Refiners Assn. in San Antonio, Texas, March 28-30. We regret that space limitations prevent publication of the complete papers, but single copies can be obtained by writing W.P.R.A., Hunt Bldg., Tulsa

New Catalytic Reforming Process Shows High Octane Gain, Low Volume Loss

A NEW catalytic reforming process for octane improvement of straight-run naphthas and gasoline, and natural gasoline, was announced by Universal Oil Products Co. at the 37th annual convention of the Western Petroleum Refiners Assn., in San Antonio, March 28-30.

The process has been christened "Platforming" because of the use of platinum in connection with the catalyst. It was developed by UOP through a long period of laboratory and pilot-plant operations. While no technical details regarding it are as yet being made public, it was announced that its applications could immediately be discussed with individual refiners.

The process is said to combine the features of providing a large gain in octane number, low volumetric loss, and moderate plant and operating costs. It also was stated that about 90% of the sulfur in the charge naphtha or gasoline is removed in the process, the catalyst not being affected by sulfur.

Plant requirements are simple, involving a preheating and reactor section, recycle gas compressor, and conventional fractionation for feed preparation and product recovery. An already installed thermal reforming unit can be converted to the new catalytic process.

The Platforming process is described as being continuous and non-regenerative and it is believed that it can be operated from 4 to 6 months without interruption. It will be practicable to install units of as small charge capacity as 1000 b/d. A cost estimate figure of around $1,700,000 was given for a unit of 5000 b/d charge capacity. In general it was stated that installation costs would be about the same as for thermal reforming plus polymerization, and operating costs slightly higher.

Data from pilot-plant operations showed yields from reforming a Mid-Continent naphtha to be as high as 95 vol.-% for Platforming, as compared with 66 vol.-% for thermal reforming, and as high as 99 vol.-% where outside butane was used. Octane numbers of the reformate product were shown to range from 87.3 to 89.5 Motor, leaded, and from 92 to 95 Research, leaded, on straight-run naphthas and gasolines from various crudes, and from natural gasoline.

The announcement concerning the Platforming process was made during the presentation before the WPRA convention of a paper entitled "Trends in Petroleum Refining", given by Edwin F. Nelson, vice president of UOP. The portion of the paper devoted to Platforming follows:

"The development of Platforming has been a co-operative effort of many departments and individuals (of UOP). Dr. Vladimir Haensel, who conceived the original idea and directed the research group carrying out the work will present as soon as possible a paper giving the scientific phases of this process.

"Platforming is a catalytic process for improvement of straight-run or natural gasolines which combines the desirable features of (1) large octane number gain, (2) low volumetric loss, (3) moderate plant and operating costs. The great yield-octane advantage of Platforming is demonstrated by Table 1, showing comparative results on a typical Mid-Continent naphtha.

"The ideal reaction in hydroforming is dehydrogenation of a naphthene to an aromatic. This reaction is beneficial to the octane number, but involves a severe volumetric loss, due to the high density of aromatics. In most straight-run stocks, however, 60-80% of the material cannot undergo this ideal reaction, but is subject to less desirable side reactions. The situation is reminiscent of thermal reforming, where only the higher boiling paraffinic part of the charge is capable of the preferred reaction. In both cases the predominant part of the charge has no possibility of a beneficial reaction.

"Considerations of this character played an important role in the development of Platforming, which combines many of the best features of

TABLE 1—Comparison of Yields in Reforming A 200—400° F. Midcontinent Naphtha, 12.0 K, 35 Motor Clear Octane Number

	Thermal Reforming	Thermal Reforming + Polymerization	Polyforming	Hydroforming	Platforming
Yield—Vol.-%					
10 lbs. R.V.P. or less	66	80	80	84	95
Outside Butane Required					
For 10 lbs. R.V.P.—Vol.-%	0	2	0	6	4
Yield—Vol.-%					
Including Outside Butane	66	82	80	90	99
Octane Ratings					
Motor Method (F-2)					
Clear	75	75	75	75	75
With 3 CC. T.E.L.	84	84	85	86	87
Research Method (F-1)					
Clear	85	85	86	81	80
With 3 CC. T.E.L.	93	93	..	93	93

both hydroforming and thermal reforming. Platforming is like hydroforming in being a catalytic process in which hydrogen recycle is employed to suppress carbon formation. In Platforming, however, this suppression is substantially complete, and the operation is continuous and non-regenerative, like thermal reforming. In Platforming, naphthenes are converted to aromatics, high boiling paraffins to lower boiling ones, and low boiling paraffins isomerized, thus providing a desirable reaction pattern for almost all parts of the charge.

"The foregoing discussion explains in a general way how Platforming can produce the superior results shown in Table 1. While the theory is relatively simple, its actual working out has been a long and difficult process. It has been necessary to obtain the proper balance between aromatization and hydrocracking and isomerization reactions, while maintaining conditions which suppress carbon formation. This has been accomplished largely by unusual techniques of catalyst manufacture.

"The Platforming process is applicable to all types of straight-run stocks in the gasoline boiling range. Typical results on a variety of stocks are shown in Table 2. It will be observed that Platforming gives about 90% sulfur reduction. The Platformate has an end point slightly above that of the charge, but does not require rerunning. ASTM gum is low, and inhibitor susceptibility satisfactory. Of considerable interest is a road rating of 100 on a leaded Platforming gasoline with a 95 Research rating.

"The plant is simple, involving merely a preheating and reactor section, a recycle gas compressor, and conventional fractionation for feed preparation and product recovery.

"The installation cost for Platforming is about the same as for thermal reforming plus polymerization. The operating cost is slightly greater than for thermal reforming plus polymerization for the same octane level. The substantial yield advantage for Platforming makes this process more economical at octane levels as low as 85 Research with 3 cc. of lead. The margin favoring Platforming becomes increasingly great for higher octane levels."

TABLE 2—Typical Results in Platforming Various Charge Stocks

Type Charging Stock	——Straight-Run Naphtha and Gasoline——					Natural Gasoline
Source, Charge Stock	Michigan	Pennsylvania	Mid-Continent	Mid-Continent	Gulf Coast	Cotton Valley
Properties of Charge Stock						
Gravity A.P.I.	58.0	56.7	54.2	57.7	57.6	68.0
Boiling Range ° F.	158–387	226–350	182–402	108–392	132–399	106–359
R.V.P. Lbs.	1.9	0.5	0.4	5.4	5.0	6.6
Sulfur %	0.11	0.06	0.03	...	0.02	0.01
Characterization Factor	12.09	11.95	11.95	11.99	11.95	12.30
Molecular Weight	119	116	125	112	112	98
Octane Rating						
Motor (F-2)						
Clear	24	41.8	34.6	48.9	50.1	56.8
With 3 CC. T.E.L.	39.7	62.9	59.1	69.8	73.3	78.9
Research (F-1)						
Clear	24.9	39.2	34.8	49.5	54.6	57.2
With 3 CC. T.E.L.	41.2	61.3	60.3	70.0	74.5	80.0
Properties of Product Reformate						
Yield, Vol. % Charge	93.0	94.1	91.3	93.0	93.1	90.5
Gravity °A.P.I.	58	57	53	55	57	70
Boiling Range ° F.	100–410	100–370	98–410	100–430	102–415	95–375
R.V.P. Lbs.	9.5	9.4	8.4	10.1	9.5	10.0
Sulfur %	0.01	0.006	0.003	...	0.002	0.001
Octane Rating						
Motor (F-2)						
Clear	77.0	75.7	78.3	77.2	78.2	77.0
With 3 CC. T.E.L.	87.5	87.3	88.5	88.8	89.2	89.5
Research (F-1)						
Clear	81.5	80.6	84.7	84.3	85.0	80.9
With 3 CC. T.E.L.	92.5	92.2	94.5	95.1	95.0	93.5

Houdriflow Catalytic Cracking Applied to Current Economics

Condensed version of paper entitled "Various Refinery Applications of Houdriflow Catalytic Cracking," by Dr. C. C. Peavy, Messrs. W. Weinrich, H. D. Noll, and G. F. Hornaday, Houdry Process Corp., Philadelphia; presented before 37th annual Meeting, Western Petroleum Refiners Assn., San Antonio, March 28-30.

REFINERS today are confronted with a 60% increase in fuel oil stocks over January, 1948, a drop in price for distillate and residual fuels ranging from 10 to 30% and the development of a buyers' market which may result in an "octane race" in motor fuels and thereby require installation of additional catalytic cracking capacity. It is stated that catalytic cracking is the best available tool to bring production of fuel oil into balance, while the sharp drop in fuel oil prices makes it expedient to review the economics of refinery cracking operations.

The economics of four typical refinery operations have been studied: Thermal cracking alone; and combinations of Houdriflow catalytic cracking with vacuum distillation, vis-breaking, and delayed coking of the reduced crude. Two alternate schemes also are presented to show the effect of catalytically cracking the recycle stock instead of thermally cracking.

The processing schemes are described below:

1. THERMAL. This consists of conventional two-coil thermally cracking the 40 vol.-% East Texas residuum to an ultimate yield of motor gasoline.

2. VACUUM DISTILLATION. The 40 vol.-% East Texas residuum is vacuum distilled to produce an 8.0 vol.-% asphalt. The vacuum gas oil plus excess light virgin gas oil is catalytically cracked and the catalytic cycle stock remaining after blending the tar bottoms to No. 6 fuel oil specification is thermally cracked.

3. VIS-BREAKING. The 40 vol.-% East Texas residuum is charged to a flash tower and the resulting bottoms is vis-broken and returned to the common flash tower. The tower overhead stock, plus excess virgin gas oil, is catalytically cracked. The catalytic cycle stock remaining after blending tar bottoms to No. 6 fuel specification is thermally cracked.

4. COKING. The 40 vol.-% East Texas residuum is flash-distilled to obtain an overhead fraction and the bottoms coked. The combined flash tower overhead and total coker distillate, plus excess light virgin gas oil, are catalytically cracked. Catalytic cycle stock is thermally cracked.

The basic yield data on which this survey is based were obtained during an extensive pilot plant program by the Houdry laboratories to determine the effect of stock preparation methods on the catalytic cracking characteristics of the resulting stocks. Stocks were prepared from East Texas reduced crude by coking, vacu-

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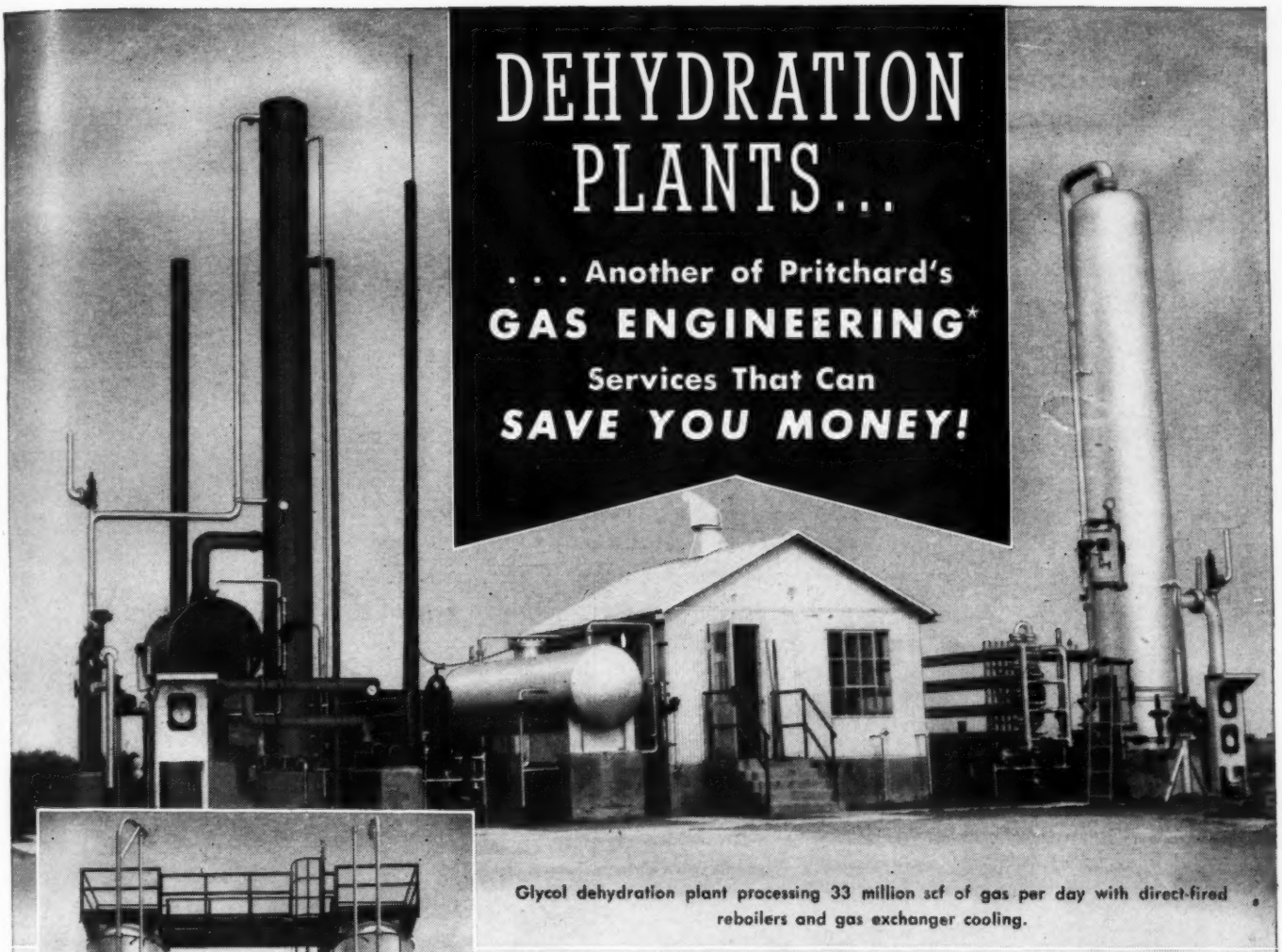
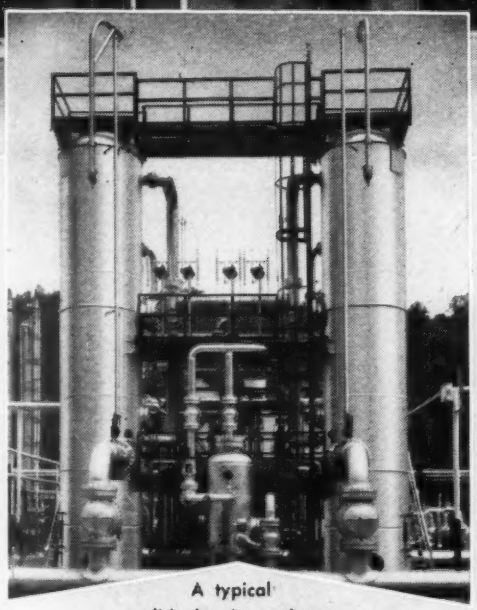


Glycol dehydration plant processing 33 million scf of gas per day with direct-fired reboilers and gas exchanger cooling.



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Trim Size	Cv	CC
1	0.63	2385
2	0.40	1514
3	0 25	946
4	0.16	605
5	0.10	378
6	0.063	238.5
7	0.040	151.4
8	0.025	94.6
9	0.016	60.5
10	0.010	37.8
11	0.0063	23.85
12	0.0040	15.14
13	0.0025	9.46
14	0.0016	6.05
15	0.0010	3.78

★ The valve flow coefficient "Cv max." at one inch of lift, is equal to the rate of flow in GPM of water (or equivalent "cc") at one psi pressure drop across the valve body. The minimum flow will be 1/50 of Cv max., shown in the table.

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TABLE 1—Summary of Processing Economics, Processing 10,000 B/CD East Texas Crude

Scheme Number		1		2		3		4		3A		4A	
Processing		Thermal		Vac. Dist. Once-Thru Cat. Crack.		Visbreaking Once-Thru Cat. Crack.		Coking Once-Thru Cat. Crack.		Visbreaking Recycle Cat. Crack.		Coking Recycle Cat. Crack.	
Revenue	$/Bbl.	B/CD	$/Day	B/CD	$/Day	B/CD	$/Day	B/CD	$/Day	B/CD	$/Day	B/CD	$/Day
10# RVP Motor Gasoline	$ 4.830	6,126	29,589	6,694	32,332	6,797	32,830	7,370	35,597	6,745	32,578	7,120	34,390
Diesel Fuel	3.570	1,000	3,570	1,000	3,570	1,000	3,570	1,000	3,570	1,000	3,570	1,000	3,570
No. 2 Fuel	3.570	....	....	....	....	....	....	....	....	505	1,803	629	2,246
No. 6 Fuel	1.50	2,378	3,567	1,781	2,672	1,623	2,435	826	1,239	1,024	1,536	243	365
Dry Gas (F.O.E.)	1.50	739	1,109	744	1,116	794	1,191	858	1,287	753	1,130	794	1,191
Excess Butane (As Fuel)	1.05	....	....	43	45	65	68	80	84	124	130	130	136
Coke	5.00$/T.	....	....	....	....	....	....	....	220	....	....	....	220
Total Revenue			37,835		39,735		40,094		41,997		40,747		42,118
Operating Costs													
Crude	2.95$/B.	10,000	29,500	10,000	29,500	10,000	29,500	10,000	29,500	10,000	29,500	10,000	29,500
Crude Distillation	...	10,000	772	10,000	772	10,000	772	10,000	772	10,000	772	10,000	772
Houdriflow Cracking	...	....	....	4,157	703	4,272	812	4,767	815	8,544	1,063	9,534	1,093
Gas Plant	...	....	238	....	592	....	605	....	654	....	629	....	679
Thermal Cracking	...	4,960	1,089	1,552	489	1,614	500	2,083	585	....	....	....	....
Thermal Reforming	...	1,990	453	1,990	453	1,990	453	1,990	453	1,990	453	1,990	453
Vacuum Distillation	...	....	....	4,000	355	....	....	....	....	....	....	....	....
Coking	...	....	....	....	....	....	....	1,497	427	....	....	1,497	427
Catalytic Polymerization	...	261	226	358	256	373	261	422	276	373	261	407	272
TEL to 80 O.N. (F-2) (1,000 cc's)	0.22c/cc	437	962	210	464	228	502	337	742	147	324	203	447
Gasoline Inhibitor	...	6,241	6	6,694	7	6,797	7	7,370	7	6,745	7	7,120	7
Taxes, Int. Ins.	...	....	401	....	647	....	589	....	695	....	586	....	678
Houdriflow Royalty	5.0c/B.	....	....	4,157	208	4,272	214	4,767	238	4,272	214	4,767	238
Thermal Royalty	3.0c/B.	6,950	209	3,542	106	3,604	108	4,073	122	1,990	60	1,990	60
Cat. Poly. Royalty	21.0c/B.	261	55	358	75	373	78	422	89	373	78	407	85
Total Operating Costs			$33,911		$34,627		$34,401		$35,375		$33,947		$34,711
Earnings, $/CD	...	....	3,924	....	5,108	....	5,693	....	6,622	....	6,800	....	7,407
Payout Time, Years	...	....	2.04	....	2.53	....	2.07	....	2.10	....	1.72	....	1.83
TEL to 78 on (F-2) (1,000 cc's)	...	283	$ 623	104	$ 229	114	$ 251	186	$ 409	65	$ 143	96	$ 211
Earnings, $/CD	...	....	4,263	....	5,343	....	5,944	....	6,955	....	6,981	....	7,643
Payout Time, Years	...	....	1.89	....	2.42	....	1.98	....	2.00	....	1.68	....	1.77
TEL to 82 on (F-2) (1,000 cc's)	...	669	$ 1,472	388	$ 854	399	$ 878	557	$ 1,226	306	$ 673	389	$ 855
Earnings, $/CD	...	....	3,414	....	4,718	....	5,317	....	6,138	....	6,451	....	6,999
Payout Time, Years	...	....	2.35	....	2.74	....	2.22	....	2.27	....	1.82	....	1.94
Investments (Process Equipment Only)													
Crude Distillation	...		$700,000		$700,000		$700,000		$700,000		$700,000		$700,000
Houdriflow Catalytic & Feed Prep.	...		.....		1,505,000		1,550,000		1,600,000		1,900,000		1,960,000
Vacuum Unit	...		.....		500,000		.....		.....		.....		.....
Gas Plant	...		680,000		775,000		800,000		840,000		825,000		850,000
Thermal Cracking & Reforming	...		1,180,000		800,000		800,000		880,000		400,000		400,000
Cat. Poly. & Feed Treating	...		370,000		440,000		450,000		485,000		450,000		470,000
Coker	...		.....		.....		.....		570,000		.....		570,000
Total	...		$2,930,000		$4,720,000		$4,300,000		$5,075,000		$4,275,000		$4,950,000

um distillation and by vis-breaking to various severity levels. Stocks were cracked in a pilot catalytic cracking unit. Gasoline and fuel blends were prepared and tested.

In the economic study of Table 1, the crude charge is assumed to be 10,000 b/cd. of East Texas crude. Crude is distilled to obtain a 250° F. end point straight-run gasoline, a 250-400° F. straight-run naphtha, a light gas oil for Diesel or No. 2 fuel, and a 40 vol.-% residuum. The 250° F. E.P. straight-run gasoline is used directly in the final motor gasoline blend. The 250-400° F. naphtha is thermally reformed to obtain a 70 octane distillate. It was assumed that 1000 b/d of light gas oil goes to sales and the remaining 960 b/d is available as catalytic cracking charge stock. The C_3 and C_4 fractions from the thermal and catalytic operations are charged to a catalytic polymerization unit to produce polymer for use in the motor gasoline blend. In Table 2 are listed the typical Gulf Coast price structure and utility values were assumed to be representative of the prices as of March 17, 1949. To convert Table 1 to a study for a particular refinery it is suggested refiners substitute their own price structure.

Overall maintenance cost used in Table 1 for processing equipment was assumed as 4.0% of the investment. Taxes, interest and insurance costs were estimated at 5.0% of investment. Royalty rates were assumed to be 5c per bbl. of fresh feed for catalytic cracking, 3c per bbl. of fresh feed for thermal cracking and reforming, 0.5c per gal. of polymer for catalytic polymerization. Investment figures are limited to the primary processing equipment only, and do not include storage or off-site auxiliary facilities.

TABLE 2—Product Prices and Utility Values

Stock	Price
East Texas Crude, Bbl.	$2.95
Motor Gasoline, Gal.	0.115
Diesel Fuel, Gal.	0.085
No. 2 Fuel, Gal.	0.085
No. 6 Fuel, Bbl.	1.50
Butanes, Gal. (Fuel Value)	0.025
Fuel Gas, MM B.t.u.	0.25
Steam, M Lbs.	0.35
Power, K.W.H.	0.008
Water (Cooling), M Gal.	0.005
Water (Treated), M Gal.	0.15
Clay Catalyst, Lb.	0.05

Processing Equipment

A conventional two-coil thermal cracking unit was assumed to handle the East Texas residuum with provision for vis-breaking it and cracking the light oil. A conventional vacuum tower is used to flash the reduced crude. Vacuum gas oil is charged to the catalytic unit.

In order to minimize the investment by eliminating a flash tower, an integral type flow is used. Reduced crude is charged to a flash tower

TABLE 3—Comparison of Processing Schemes Producing 80 oct. Gasoline

Scheme No.	Processing	Investment $1000	Payout Period Yrs.	Earnings $/CD	No. 6 Fuel Produced % on Crude	c.c. T.E.L. to 80 Oct. Motor
1	Thermal	$2,900	2.04	3,924	23.78	1.7
2	Vacuum Distillation	4,720	2.53	5,108	17.81	0.75
3	Vis-breaking	4,300	2.07	5,693	16.23	0.80
4	Coking	5,075	2.10	6,622	8.26	1.09
3A	Vis-breaking—Recycle Cat. Cracking	4,275	1.72	6,800	10.24	0.52
4A	Coking—Recycle Cat. Cracking	4,950	1.83	7,407	2.43	0.68

and resulting bottoms is charged to a vis-breaker heater and then to the common flash tower. Combined flash tower overhead vapor is charged to the catalytic unit.

A drum-type delayed coking unit is used. The charge is the 15 vol.-% residuum from flashing the 40% East Texas residuum in an atmospheric flash tower. Coker overhead products combine with flash tower overhead for catalytic processing.

The new Houdriflow catalytic cracking process is used in all of these studies. For a description of this process, which retains the desirable features of the conventional TCC process and contains a number of features giving greater flexibility and low cost, see PETROLEUM PROCESSING; December, 1948, p. 1163; and February, 1949, p. 137.

A summary of the relative advantages of the various processing schemes when producing a gasoline with an 80 octane rating by the F-2 or Motor Method is given as Table 3. This indicates that, at the present gasoline prices and providing the refiner has a market for coke, the delayed-coking process is an attractive method for preparing catalytic cracking feed stocks. Although the coking scheme results in the largest investment, the payout time compares very favorably with the other processes and the earnings per day are appreciably higher than for the other processes.

Vis-breaking compares favorably with the coking process in that it has a lower investment, slightly lower payout time, but produces lower earnings. Recycle catalytic cracking of the cycle stocks (Schemes 3A and 4A) indicates reduced payout times and higher earnings over once-through catalytic cracking followed by thermal cracking of the net cycle stocks after fuel blending.

The Houdriflow catalytic cracking unit is capable of handling cycle catalytic stocks ranging from material having an initial boiling point of 400° F. to an end point of 1000° F. Feed may be in the liquid or vapor phase as charged, or a mixture of the two. Final vaporization prior to cracking results from the hot catalyst (1000 to 1150° F.) and the presence of steam.

Basic yield data for the various operations are shown in Tables 4, 5 and 6, which are self-explanatory.

Processes Compared

Plots of pay-out time vs. price of residual fuel with once-through and recycle catalytic cracking, and differential earnings and payout times vs. various gasoline prices are presented in the original paper but omitted here. Variations in the fuel price produce the greatest effect on earnings of those processing schemes producing the most residual fuel. Recycle catalytic cracking minimizes residual fuel when compared with once-through catalytic cracking followed by thermal cracking of the catalytic cycle stock. The recycle operation is affected less by the price of fuel and shows considerable advantage over once-through cracking.

As the gasoline price increases, with fuel prices remaining constant, the advantage of the coking, vacuum-flashing and vis-breaking methods over thermal cracking increases. The differential earnings between the various processing schemes are only slightly affected by substantial changes in gasoline prices.

The lead requirements for the motor gasoline blends vary appreciably, depending on the method of processing. A brief summary of the lead requirements is given in Table 7.

On the basis of this summary it is apparent that, as the octane level is increased, the advantage of catalytic over thermal cracking increases. The advantage of coking over vis-breaking decreases because of the higher lead requirement. The higher lead requirement results from the lower octane number of the coker gasoline.

If the lead content of the gasoline had been held constant, and the octane difference corrected by the amount or severity of naphtha reforming, the relative advantage of catalytic over thermal cracking would be enhanced.

The following conclusions are drawn from the economic studies presented:

1. At the present market conditions, coking or vis-breaking are the best methods for preparing catalytic cracking charging stocks.

2. More catalytic cracking capacity appears necessary because of the octane advantage of catalytic over thermal gasolines.

3. The use of catalytic cracking is advantageous to minimize the production of residual fuel.

TABLE 4—Thermal Reforming Yields, Schemes 1 to 6

Charge to Unit, B/CD	
250-400° F. Naphtha	1,960
Yields Based on Charge, Vol.-%	
Debut. Gaso.	73.5
Fuel Oil	3.0
Isobutane	1.5
Normal Butane	2.3
Butenes	5.4
Propylene	5.1
Dry Gas (C_3 + Lighter), Wt.-%	15.3
Octane Ratings (F-2)	
Charge	46.0
Product	70.0

TABLE 5—Houdriflow Catalytic Cracking Yields

SCHEME NUMBERS	2	3	4	3A	4A
Charge to Unit, B/CD					
Diesel Fuel	960	960	960	960	960
Flash Tower overhead					
Virgin	....	2,504	2,504	2,504	2,504
Visbreaker	....	808	....	808	....
Coker Overhead	....	....	1,303	....	1,303
Vacuum Gas Oil	3,179	....	....	....	....
Recycle	....	....	....	4,272	4,767
Total	4,139	4,272	4,767	8,544	9,534
Yields Based on Fresh Charge, Vol.-%					
Debutanized Motor Gasoline	42.0	41.8	43.2	59.0	59.4
Catalytic Gas Oil	45.8	44.2	43.7	18.2	18.3
Isobutane	5.0	5.1	5.1	7.4	7.1
Normal Butane	1.8	1.9	2.0	2.7	2.7
Butenes	4.3	4.3	4.8	5.5	5.6
Propylene	2.6	2.9	3.2	4.3	4.4
Dry Gas (C_3 + Lighter), Wt.-%	5.9	6.8	6.2	10.7	10.5
Carbon, Wt.-%	4.6	5.0	5.5	8.4	9.5
Carbon, #/Hr. (Stream Day)	2,710	3,020	3,717	5,140	6,489

TABLE 6—Thermal Cracking Yields

Scheme Numbers	1	2	3	4
Charge Stock, B/CD				
Diesel	960	....	....	....
Reduced Crude	4,000	....	....	....
Catalytic Gas Oil	....	1,552	1,614	2,083
Total	4,960	1,552	1,614	2,083
Gravity, °API	24.8	28.5	26.9	27.6
Yields Vol.-%				
Debutanized Motor Gasoline	43.4	47.5	47.7	47.1
Isobutane	1.8	1.4	1.4	1.4
Normal Butane	1.4	3.2	3.4	3.3
Butenes	2.6	3.6	3.6	3.6
Propylene	2.1	3.0	3.0	3.0
Fuel Oil	46.7	36.5	37.1	36.8
Dry Gas (C_3 + Lighter), Wt.-%	8.3	12.5	12.5	12.5

TABLE 7—Comparison of Lead Requirements by Processing Schemes for Various Octane Numbers

Scheme No.	Processing	Lead Requirement, cc/Gal. 78 O.N.	80 O.N.	82 O.N.	84 O.N.
1	Thermal	1.1	1.7	2.6	...
2	Vacuum-Distillation	0.37	0.75	1.38	2.15
3	Visbreaking	0.4	0.8	1.40	2.2
4	Coking	0.6	1.09	1.8	2.95
3A	Visbreaking—Recycle Cat. Crack.	0.23	0.52	1.08	1.7
4A	Coking—Recycle Cat. Crack.	0.32	0.68	1.30	2.0

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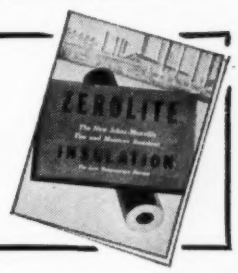

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REFRIGERATION INSULATION

Trends in Petroleum Refining

Technical developments of recent years have increased the overall complexity of refining operations. The blending of distillate fuels necessary to satisfy the volume of demand poses new problems in overcoming their tendency towards instability in storage. While the catalytic cracking process has been simplified, its installation adds to the complexity of refining operations. The present need for up-grading straight-run gasoline presents economic as well as technical problems for the refiner.

Condensed version of paper under the same title, by Edwin F. Nelson, vice president, Universal Oil Products Co., Chicago; presented before 37th Annual Meeting, Western Petroleum Refiners Assn., San Antonio, March 28-30.

THE cycle involving abundance of crude oil into which the petroleum industry now appears to be entering makes it difficult for refiners to conduct profitable operations. The most promising overall solution is a technical one: that of having flexibility of plant operations, so as to change crudes and products, or the amounts of each made, to derive quick advantage of currently existing market demand.

Another long-range major trend in refining, that of producing better quality products at lower costs, also has resulted in increased technical complexity in operations. The solution of the complex problems confronting refiners today calls for the services of experts and specialists on their staffs. The various independent organizations devoted to the technology of refining provide necessary assistance to refiners' staffs on technical matters.

MOTOR GASOLINE: The industry is back to normal pre-war conditions, with emphasis on quality, interpreted by the public as octane number. At the present time, when further increases in octane number may require substantial refinery additions, increasing attention is being given to the utilization of the octane values of present fuels in automotive vehicles, also to the test methods used for determining octane numbers.

Regular grade gasoline of 80 Research and 76 Motor will give knock-free operation for all normal driving conditions in about 40% of the cars on the road. Similar completely knock-free operation in the other 60% of the cars can only be obtained with a fuel having a Research octane number of over 90. On the average, however, maximum octane number is needed only 10% of the time. On multiplying these percentages, the average gasoline of today is found to be satisfactory over 94% of the time.

This situation represents a serious waste of expensively produced octane numbers. One approach to the problem of making better utilization of octane values present in motor fuel recognizes that the anti-knock characteristics of fuels and fuel components are also dependent on such engine variables as speed and load. Different hydrocarbon types respond to these variables in highly characteristic ways. The possibility therefore exists of blending fuels with anti-knock properties designed to match the requirements of the engine at all operating conditions. Real progress in this direction has been prevented by lack of a laboratory test method which will give a reasonable indication of road performance. Development of such a method is now being attempted by the Coordinating Research Council of the American Petroleum Institute and the Society of Automotive Engineers.

BURNER OILS: To satisfy the increasing demand for light distillates above the gasoline range, it is becoming standard practice to blend distillate fuels from all available stocks of acceptable boiling range. These blends exhibit storage instability of various kinds, including precipitate formation, darkening, and soluble gum formation.

Blends of sweetened straight-run and cracked distillates from high sulfur crudes are apparently particularly susceptible to precipitate formation, which may occur in periods of a few days to a year. In some cases precipitates have formed even in unblended straight-run distillates from high sulfur crudes. It is known that disulfides contribute to precipitate formation, and that the bad effect of sweetening is due to the conversion of mercaptans into disulfides.

Another known source of trouble is caustic washing, which may leave sodium salts of organic acids dissolved in the oil. These salts may be removed by a subsequent water wash; followed in certain cases by filtration. In certain circumstances it is possible by using dilute caustic —less than 5° Be.—to reduce the sodium salt pickup by the oil and eliminate the need for water wash. In the case of some blends where precipitate formation is particularly rapid, a reasonably stable product is obtained by carrying out the filtration after several days' storage.

While color formation does not affect performance of burner oils, it is of some importance from the sales angle. The chemistry is obscure but nitrogen bases are thought to be involved and acid treatment usually improves color stability. As usually carried out, however, acid treatment results in some sulfonation, with consequent precipitate and haze formation. The use of dilute acid is a possible solution.

Soluble gum formation is found in cracked fuels and in a few virgin fuels. Strong sulfuric acid treatment improves gum stability, at the risk of the other problems just mentioned. The suggestion has been made that soluble gum is harmful in distillate fuels, but no definite evidence of operating difficulties due to soluble gum has been obtained. This is not surprising, however, since use of distillate fuels in domestic oil burners or diesel engines does not involve conditions resembling those found in the automotive carburetor and intake manifold.

Solvent extraction to remove heavy aromatic oils and improve cetane number may offer a possibility of up-grading heavy cracked distillates.

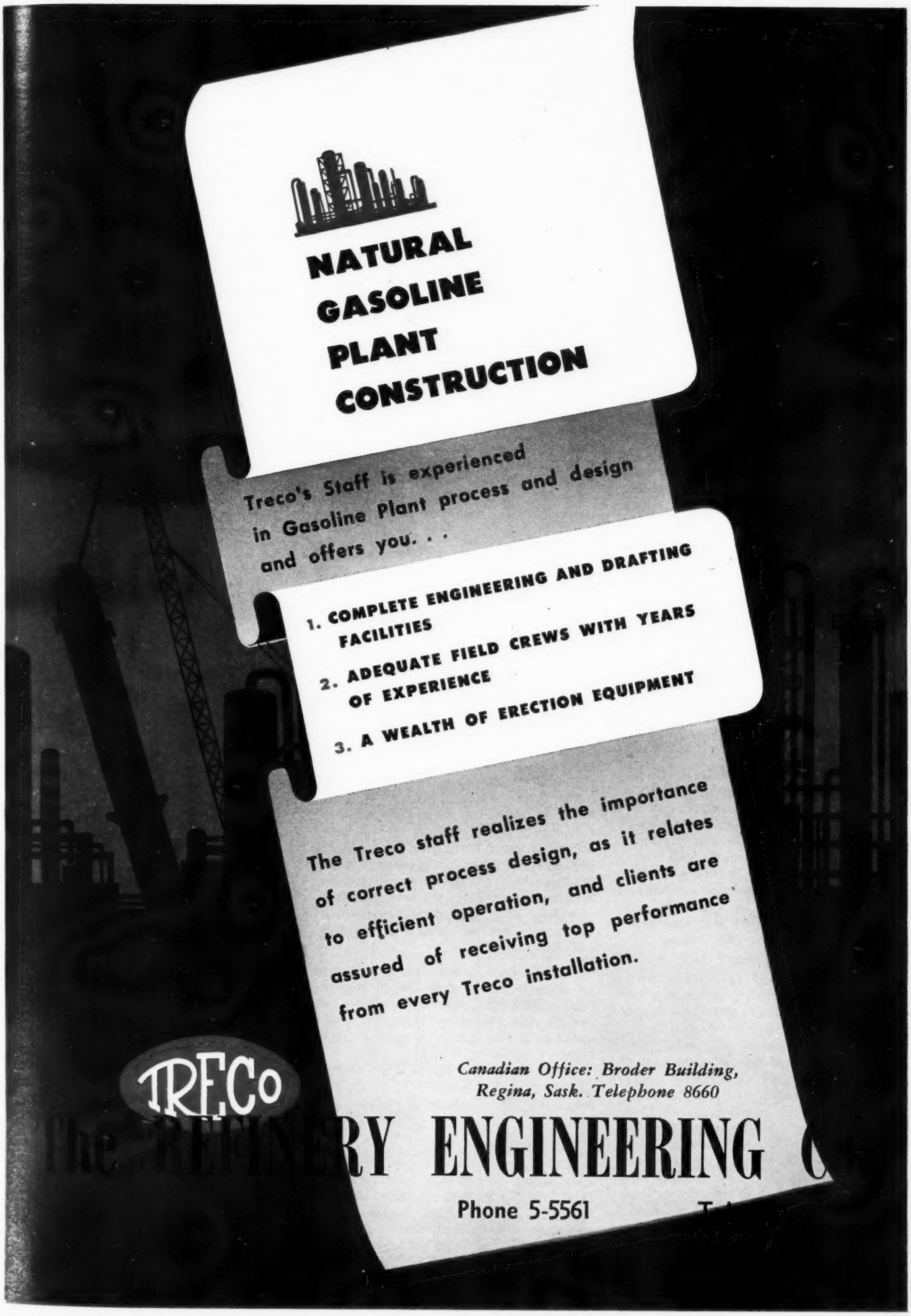
RESIDUAL FUEL: The refiner of today is under increasingly heavy economic pressure to reduce his residual fuel oil production. A variety of methods are available, depending upon his present operations. Refineries having only topping facilities have the following choices:

1—Adjustment of crude tower operations to produce maximum amounts of distillates.

2—Installation of a vacuum unit to produce virgin asphalt. The wisdom of this step depends largely upon the available asphalt market.

3—Installation of vis-breaking, thermal cracking, catalytic cracking, or coking units.

Refineries in which some of these processes are already installed have a correspondingly limited choice. Refineries without catalytic cracking can achieve a substantial reduction in residual fuel production by installing such facilities. In a typical refinery processing Mid-Continent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crude this step will reduce residual fuel by 30 to 40%. The present trend toward lower residual fuel prices has caused many refiners to consider converting more refinery fuel gas into polymer gasoline and offsetting the reduction in fuel gas by burning pitch or residual fuel.

PETROCHEMICALS: Various difficulties frequently appear on investigation of this field by refiners. One of these is that the light olefins, which are the most important petrochemical raw material, are only available in sufficient quantities at rather large refineries. Substantial capital investment is involved in most petrochemical developments. The smaller refinery, however, may occasionally find the opportunity to dispose of raw materials to a nearby chemical plant. In carrying out limited manufacture of chemicals, some refiners have found it profitable to modify their poly plant operations to produce propylene tetramer, which is an intermediate in detergent production.

WASTE DISPOSAL: Refiners are being forced to devote more attention to waste disposal. Increasingly stringent regulations govern both the analysis of water discharged into lakes or streams, and the solids and sulfur content of stack gases. The combined impact of these regulations and the shift to high-sulfur crudes is forcing an increasing number of refiners to include production of sulfur or sulfuric acid in their operations.

CATALYTIC CRACKING: Catalytic cracking offers an interesting example of the early complex solution to a complex problem, followed by simpler solutions as the problem was further investigated. The first commercial fluid unit, built by Standard Oil Co. of Louisiana at Baton Rouge and placed in operation in 1942, was the result of bold and brilliant pioneering by the Jersey organization.

As a result of the experience with commercial units and of studies in pilot plants, it was concluded that great simplifications in design were possible, and would be most advantageous from the standpoint of capital investment, operating cost and yield and quality of product. The first commercial installation of this improved design, made by the Aurora Gasoline Co. at Detroit, has now been in operation almost two years. Nine units of this design, with a total capacity of 80,000 b/d charging capacity, are under construction.

CRACKING CATALYSTS: Three basically different types of catalysts are used commercially: 1) the natural catalyst, as typified by super filtrol, an acid-treated bentonite clay; 2) silica-alumina catalyst, which consists fundamentally of alumina with silica gel; and 3) silica-magnesia catalyst, similar to silica-alumina except that magnesia replaces the alumina.

Natural catalyst is less uniform in quality than the prepared and is adversely affected when exposed to high-sulfur feed stocks and higher temperatures. Its lower price makes it attractive where circumstances will permit its use. Synthetic silica-alumina continues to hold a leading position due to its properties, which combine catalytic stability and high octane of the product. Silica-magnesia is now commanding attention because of its better resistance to steam deactivation and because a greater yield of gasoline can be obtained from a given quantity of feed stock. This additional gasoline is obtained largely through a reduction in yield of C_4 fractions. The gasoline produced is less volatile and lower in octane number than that obtained through the use of silica-alumina catalyst.

Both synthetic varieties can be produced either as ground powder or in the form of microspheres. The latter form is coming more and more into use since it reduces mechanical wear of both the catalyst and physical plant equipment.

TREATING "CAT-CRACKED" GASOLINE: While these gasolines are fundamentally more stable than thermal gasolines, they contain small concentrations of thiophenols and other acid oils. Thiophenols are detrimental to storage stability but are quite acidic and are easily removed by a simple caustic wash. Acid oil content generally must be reduced to avoid gum formation and this is also accomplished by a caustic wash. Addition of a potent synthetic inhibitor to caustic washed catalytic gasoline will almost always result in a product of superior stability characteristics.

The mercaptan content of catalytic gasoline is low and if the proper inhibitor is added, sweetening will occur in the rundown tanks in most cases in a few hours. A typical catalytic gasoline treating system is simpler than is required for thermal gasoline and consists of a caustic wash and an inhibitor injection system.

REFORMING: The industry has available a number of processes for up-grading low-octane, straight-run gasoline. Each suffers from one or more of the following major disadvantages; 1) limited octane number improvement, 2) high volumetric loss, and 3) high plant and operating cost.

These processes, however, have been more and more adopted as a result of irresistible pressure for higher octane gasoline. They include: 1) mercaptan extraction, 2) hot clay or bauxite treatment, 3) thermal reforming, 4) thermal reforming plus catalytic polymerization, 5) polyforming, and 6) hydroforming.

The first two of these are essentially desulfurization processes, which give moderate improvements in leaded octane numbers at high yields and low operating costs. Refiners so situated that they can meet their octane requirements by such processes will continue to find them satisfactory. The other processes listed are capable of producing substantial improvement in octane number but at the expense of lower yield and higher cost.

The most important reaction in thermal reforming is cracking. All hydrocarbons can be cracked but in general the paraffins are somewhat more susceptible to this reaction than other constituents of straight-run gasoline. Among the paraffins, there is a definite increase in cracking susceptibility with boiling point. The liquid products of paraffin cracking have improved octane numbers both because they are lower in molecular weight and because they are somewhat unsaturated. It is evident from this picture that thermal reforming does have a certain inherent selectivity, which is reflected in the first part of the yield-octane curve, which shows a relatively steep rise in octane number. The volumetric loss is almost entirely represented by gas, with only a slight formation of higher boiling materials.

Unfortunately, the initial slope of the yield-octane curve is not long maintained, and a limiting octane number is reached which cannot be significantly increased, no matter what loss is taken. This situation reflects the fact that the inherent selectivity of thermal reforming is almost completely exhausted at a yield of 80-85%. The products of selective thermal reforming are not of exceptionally high octane number, and hence the yield-octane curve becomes flat at an undesirably low level.

The gas loss in thermal reforming has a substantial olefin content and polymerization, therefore is a natural supplement to thermal reforming. The most common form of this combination is the use of the UOP polymerization process to convert C_3 and C_4 olefins to polymer gasoline. Addition of this polymer to the thermal reformate raises both yield and octane number, and therefore makes a substantial improvement in the yield-octane curve, which eventually, however, flattens out at too low an octane number. One contributing factor here is that at increasing thermal conversions the C_3 and C_4 olefins constitute a decreasing percentage of

the total gas made. The addition of catalytic polymerization improves the selectivity of thermal reforming, but is unable to correct the production of large quantities of saturated gases.

Polyforming combines thermal reforming with polymerization. By recycle of C_3 and C_4 gases to the reforming zone, their olefinic constituents are to some extent forced into liquid-forming reactions. While the chemistry is not identical in detail with that of the thermal reforming—catalytic polymerization combination, the same general considerations apply.

Hydroforming is a completely different approach to the problem of octane improvement of straight-run gasoline. From the plant operator's viewpoint it differs in being a catalytic process, in recycling large amounts of hydrogen, and in requiring frequent regeneration of the catalyst by burning off carbon. From the chemist's standpoint the differences are just as great. While the typical reaction in thermal reforming is cracking of heavy paraffins to lighter paraffins and olefins, in hydroforming it is dehydrogenation of naphthenes to aromatics. In hydroforming, as in thermal reforming, the principal by-product is light gas. However, the gas is saturated and cannot be converted to polymer. The yield-octane curve for hydroforming is similar to that for thermal reforming plus polymerization. Necessity for regeneration leads to high plant and operating cost.

(The remainder of Mr. Nelson's paper is devoted to the new Platforming process, which is described briefly in this issue, beginning on pg. 553.)

Reforming Methods Compared For Sweet and Sour Naphthas

Material in this article is based on the paper, "Hydroforming and Thermal Reforming Operations on Sweet and Sour Heavy Straight-run Naphthas," presented before the 37th Annual Meeting of the Western Petroleum Refiners' Assn., San Antonio, March 28-30. Authors are N. H. McLaurin, C. M. McIntosh, and D. S. Kaufman, all of The Texas Co.

RESULTS of an extensive pilot plant study in the research and development laboratories of The Texas Co., Port Arthur, on hydroforming and thermal reforming operations on sweet and sour heavy straight-run naphthas were presented before the WPRA meeting in San Antonio. An economic comparison also was made of the direct operating costs of the two processes. The data from these studies were summarized as follows:

1—Hydroforming was found to possess a definite yield-octane number advantage over thermal reforming.

2—When reforming to a given octane number, thermal reforming was found to be more economical below about 78 ASTM Motor octane number, and hydroforming more economical above that level. The differences were small, however, and were not considered significant.

3—Reforming operations on the sour stock were found to result in a much more attractive yield-octane number relationship than on the sweet stock.

4—The relative economics of the two processes were virtually the same for both the sweet and sour stocks.

A comparable study was also made on a low sulfur stock in order to provide a basic comparison in which sulfur reduction was not a factor. A total of 62 pilot-plant runs were made in the course of the investigation. Table 1 gives pertinent data on the charge stocks.

A single pass, coil-only thermal reforming pilot unit was employed in the thermal reforming portion of the study. Of the 18 runs made on the thermal reforming unit, 8 were made charging heavy straight-run naphtha from the sour crude and 10 runs charging heavy straight-run naphtha from the sweet crude.

The pilot unit used for the hydroforming portion of the investigation compares favorably in yield and product quality with several commercial hydroformers. The catalyst employed in the study was a molybdena-alumina hydroforming catalyst in the form of ⅜ x ⅜ in. pellets. Forty-four hydroforming runs were made under varying conditions. In both studies, hydrocarbon analyses of the gaseous fractions were obtained by mass spectrometer, while the liquid samples were analyzed by low temperature fractional distillation.

While is it recognized that the product distribution of reforming is affected by variations in pressure; the effect, according to available correlations, is not very great over relatively small ranges and was ignored in the correlations of thermal reforming results. The same is true of the effect of pressure and hydrogen recycle rate on hydroforming and the correlation of these results.

In analyzing the results of thermal reforming operations, the yields of

TABLE 1—Charge Stock Tests

Charge Stock	Heavy Straight-Run Naphtha From Sour Crude	Heavy Straight-Run Naphtha From Sweet Crude
Gravity, °API	49.1	55.5
Sulfur, Lamp, Wt.-%	0.421	0.008
Octane Numbers		
ASTM Motor—Clear	41.7	43.0
+ 3 cc. TEL/Gal.	54.4	66.4
ASTM Research—Clear	40.8	42.2
+ 3 cc. TEL/Gal.	52.7	66.8
ASTM Distillation		
IBP °F.	222	172
10% °F.	276	242
50% °F.	322	290
90% °F.	360	324
EP °F.	392	362

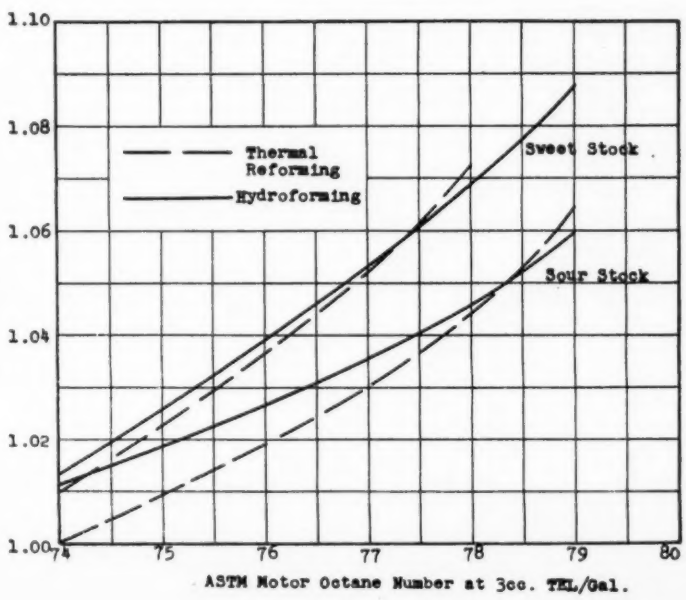

Fig. 1—Relative economy of hydroforming and thermal reforming; cost index vs. octane level

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UOP

Catalytic Polymerization Unit Added by McMurrey

By O. C. DeLoach
Secretary & Plant Superintendent
McMurrey Refining Company

A catalytic polymerization unit, recently placed on stream at the Tyler, Tex., plant of McMurrey Refining Co., marks the latest step to be completed in a program of expansion and improvement begun soon after our refinery was built in 1931.

O. C. DeLoach

The poly unit, which is of the chamber type, with a single tower and multiple catalyst beds, was designed by Universal Oil Products Co. and built by our own construction department.

Charge stock to the poly unit is the net stabilizer gas from our thermal cracking unit, also designed by UOP. Its composition and that of the polymer product leaving the poly plant are shown in the following table.

	Fresh Feed Gas Mol. %	Polymer Gasoline Liquid Vol. %
Hydrogen		
Methane	1.8	
Ethylene	1.8	
Ethane	7.6	
Propylene	14.1	
Propane	24.5	
Isobutane	3.5	0.4
Isobutylene	7.2	0.1
n-butylene	15.2	2.5
Normal butane	22.4	13.9
Pentanes	1.9	9.2
Hexanes plus		73.9
	100.0	100.0
Specific gravity of hexanes plus		0.7316
Properties of Polymer Gasoline		
End point °F		396
RVP, pounds		12.3
Specific gravity		.7082

The poly unit has been producing approximately 150 b/d of polymer, which represents about 4 per cent on the topped crude charged to the cracking unit and an 8 per cent increase in gasoline yield.

Save on Lead Requirements

Not only is the overall production of gasoline thus increased, but the addition of high octane polymer to the motor fuel considerably reduces the amount of tetraethyl lead required to maintain our octane standard at 80ASTM and 88 Research for premium gasoline. The polymer has an 82.5 ASTM octane rating and 100 ASTM blending value. Catalyst life during the first run, which ended Sept. 13, 1948, was 77.8 gallons of 2 lb. RVP polymer per pound of catalyst. Olefin conversion rate is about 90 per cent.

A number of catalytic polymerization

(Advertisement)

units have been installed since the war to process gases from catalytic cracking units. Many of these have been built by the adaptation of existing equipment. By contrast, this unit, designed to polymerize thermally cracked gases, has been built with all new material from the ground up in accordance with our policy.

In operation, the gas from the cracking plant stabilizer is caustic washed and water washed. It is then picked up by a compressor and passed through the catalyst tower, and after exchanging heat with the catalyst tower effluent, is further heated to reaction temperature by means of a hot oil exchanger. Liquid butane is employed as a quench for catalyst temperature control. The catalyst tower effluent is fractionated to produce a stabilized polymer and a butane fraction used in the gasoline blends for vapor pressure control.

Average Operating Conditions

Average operating conditions for the unit are shown below:

Catalyst Temperatures	
No. 1 bed — Avg. °F	400
No. 2 bed — Avg. °F	405
No. 3 bed — Avg. °F	410
Catalyst tower pressure	450 lbs. per square inch
Polymer production	150 B/D Average
Yield of Polymer	
Volume percent on topped crude	4.0
Olefin Contents — Mol. %	
Fresh feed	34
Combined feed	22
Butane and lighter effluent	5
Polymer Inspection	
RVP, pounds	12.0
API gravity, degrees	68.0
ASTM distillation	
IBP	95
10%	160
50%	230
70%	260
90%	360
E.P.	400
ASTM gum mgs/100 ml	1.2
ASTM octane number	82.5

Many of the advances in refinery design made since 1931 are exemplified in the McMurrey refinery of today. Originally it was a skimming and vis-breaking operation only, with a charge capacity of 12,000 barrels per day of East Texas crude. Products were straight-run gasoline, kerosene and fuel oil.

Two years later, a thermal cracking unit with a design capacity of 1,500 barrels per day of gas oil was built.

Rebuilt in 1937

In 1937 the refinery was completely rebuilt and modernized under UOP's supervision. The existing cracking plant was converted to a UOP two-coil selective cracking unit to crack 3,750 b/d of a wide variety of charging stocks.

The refinery still operates on East Texas crude, gathered and delivered to the plant by our own pipeline system. In addition to gasoline, we are now producing naphtha, kerosene, Diesel fuel and No. 6 fuel oil. These are marketed chiefly by tank car and truck.

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products were shown as functions of dry gas yield. On the basis of constant dry gas yield, a slightly higher percentage of polymer and butanes were produced from the sour stock, while the yield of debutanized naphtha was slightly lower. This difference in product distribution was considered due to the difference in the boiling range of the stocks.

Clear and leaded ASTM Motor octane numbers were correlated with naphtha yield for operations on both sweet and sour charge stocks. These correlations indicated that if stocks of essentially the same clear octane were processed, operations on the sour stocks would result in higher clear octane numbers over the entire operating range, and in a slightly higher leaded octane at the higher conversions. The variation of the ASTM Research octane number with naphtha yield for both stocks was essentially the same as for Motor octane numbers. The leaded octane number advantage for the sour stocks at high conversions in greater than was reflected by the ASTM Motor method.

A salient feature of the thermal reforming studies was the conspicuous discrepancy existing between the yield-octane number relationships obtained on the two stocks. A possible reason is the difference in the sulfur contents of the feed stocks and the desulfurization of the sour stock upon processing. Comparison of the data obtained in this study with established thermal reforming correlations indicated that:

1—The yield distribution in the study was in fair agreement with that predicted from existing thermal reforming correlations.

2—The octane improvement obtained when reforming the sweet stock was in good agreement with that predicted from the correlations, while operations on the sour stock resulted in a much higher improvement than would have been predicted.

In the study of hydroforming operations, the yields of the various products were also presented as functions of the dry gas yield. The effect of the difference in the feed stocks was indicated to be essentially the same as for thermal operations. The ASTM Motor octane number was correlated with naphtha yield for operations on the sweet and sour stocks. The results indicated that, when hydroforming two such stocks of essentially equal clear octane number, a clear octane number advantage is obtained by processing the sour stocks. A leaded octane number advantage is also shown for the sour stock at high conversion levels. The correlation of ASTM Research octane number with naphtha yield was essentially the same as for ASTM Motor octane number.

The sulfur content of the hydroformate was almost constant at about 0.005 wt.-% over the entire conversion range. This contrasts with the thermal reforming desulfurization, where the sulfur content of the reformate varied with conversion.

A comparison of the hydroforming and thermal reforming processes on a yield-octane number basis showed hydroforming to possess a definite yield-octane number advantage over the entire range of operations covered by the data.

In order to further evaluate the thermal reforming and hydroforming processes, an economic comparison was made of their direct operating costs, investment costs not being included.

This study was based on the production from both sweet and sour crude of a constant quantity of leaded base stock at various octane levels (+ 3 cc. TEL./gal.). The raw base stocks were considered to be composed of thermally cracked naphtha and light and heavy straight-run naphthas, in the ratio of their production from cracking and crude stilling operations. The total base stocks were upgraded to the desired octane level (at 3 cc. TEL/gal.) by thermal reforming and hydroforming of a portion of the heavy straight-run fractions.

The raw base stock was assumed to be available at a constant cost and in sufficient quantity to result in the production of a constant quantity of improved base stock. The relative economics of hydroforming and thermal reforming were compared on the basis of the relative costs of the final leaded blends after allowing credits for the by-products from the processing operations. Actual plant operating costs for both processes were employed in making the comparison. Investment costs were not included.

Fig. 1 presents the economic comparison of the two processes at constant lead concentration of 3 cc. TEL/gal. In this figure the cost of the upgraded base stock (expressed as a cost index, using the cost of upgrading the base stock to 74 ASTM Motor octane number by thermally reforming the sour stock as a base) is correlated with the ASTM Motor octane number level for processing both the sweet and sour stocks.

Over most of the octane number range, thermal reforming is indicated to be slightly cheaper than hydroforming. At the higher octane range (above 77.4 on sweet stock and 78.3 on sour stock) however, the cost of hydroforming appears slightly less. The differences in each case are not considered significant. It is noted that essentially the same results are indicated when comparing the two processes on either the sweet or sour stock.

Plant Practices

Practical Tips and Ideas for Improving Operations

"Straddle Dollies" Speed Construction Of Mile-long, 60-in. Cooling Water Line

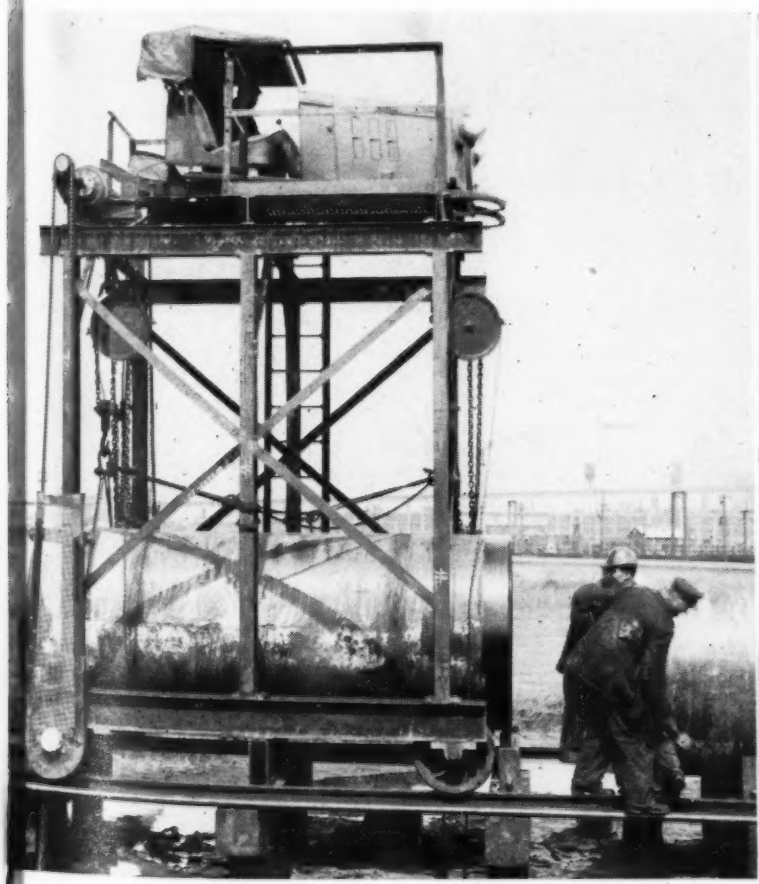
TWO shop-built pieces of construction equipment served to an advantage recently in speeding up the installation of a 60-in. pipeline, over a mile long, at the Bayway refinery of Esso Standard Oil Co.

The equipment comprised two mobile "straddle dollies" which were used in laying the new line from a pumping station on Long Island Sound to the manufacturing area of the plant, a distance of approximately 1¼ miles. The line—60-in. diameter, cast iron, cement-lined, bell and spigot type connections — provides salt water for cooling the major processing units at the refinery.

Approximately one mile of the line crosses swamps and marsh flats, and required pile supports. Instead of building a road through the construction area, Esso engineers laid railroad tracks over heavy timber ties across the pile caps. As pile work progressed, a home-made straddle dolly followed on the trucks, and was used to lay pipe and to haul supplies to and from work points.

This dolly consists of an inverted "U" frame, equipped with chain hoists, and with mobile power provided by an old automobile engine. It is shown in the accompanying photograph. The unit was equipped with railroad type wheels for movement along the tracks. A second straddle dolly, not motorized, was used for caulking the joints after the pipe had been laid. From this rolling workshop, lead was heated, poured, and the joints caulked progressively along the 60-in. line.

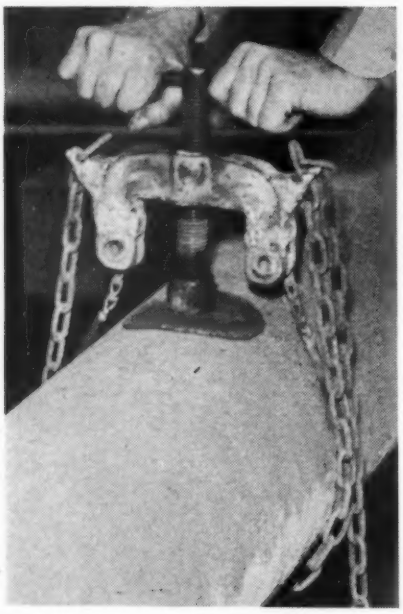
The project was designed by the Bayway engineering department and constructed by the refinery mechanical forces. It will increase coolant supply at Bayway by 120 million gals./day, bringing the total daily consumption to 310 million gals., greater than that of the city of Philadelphia.



Motorized "straddle dolly" moving a length of 60-in. pipe into position during construction of mile-long water line at Bayway

Second dolly, not motorized, follows up behind first one and serves as a mobile platform for caulking and leading joints between pipe sections

Patch Kit Facilitates Emergency Repairs On Leaks in Fluid "Cat" Carrier Lines



Sinclair's emergency patch repair kit for stopping leaks on catalyst carrying lines is kept available on the Fluid unit at all times

EMERGENCY repair patch kits, kept on hand in the control room of the Fluid Catalytic Cracking unit at the Marcus Hook refinery of Sinclair Refining Co., facilitate the quick stopping of leaks that may develop in the catalyst carrying lines.

When such leaks develop it is very important that they be stopped as soon as possible, because they increase rapidly in size and soon become too large to repair. In the past, whenever a leak was discovered a welder was sent for immediately. If his services were required during the second or third tours, from 4:30 p.m. to 8:00 a.m., it was necessary to call him from home, because welders ordinarily work only during daylight hours. Occasionally, considerable time would elapse before a welder reached the job.

It then was necessary for him to prepare a suitable patch, place it over the leak and begin welding. During the time that elapsed between the discovery of the leak and the beginning of the welding, the leak increased in size considerably, and the catalyst blowing out made work difficult.

The new repair kits comprise a number of metal patches of various shapes and varying radii of curvature, and a tool with which the patch of correct dimensions and shape can be pressed against the leak. In this way, the leak is sealed temporarily and is prepared in advance for the work of the welder when he returns on his regular shift the following day.

The photograph shows the "patch clamp" in position on a line. This clamp was fabricated from the top half of an old pipe vise, a length of chain, and especially cut pipe and plate patches. A set of circular sheet asbestos gaskets, ⅛-in. thick, complete the kit.

The clamp will fit any size pipe from 3 in. to 5 ft. in diameter simply by varying the length of the chain. The stock of patches is obtained from the refinery scrap pile by cutting pieces of old pipe bends, ells, and other fittings to obtain pieces having the desired radii of curvature.

In the event of a leak occurring in an area which will not permit the chain being wrapped around pipe, use is made of pieces of flat bar about 2 by ½ in. and long enough to reach from each side of the clamp head to some object to which the bars may be tack-welded, thus holding the patch in position over the leak.

Included in the emergency patch repair kit are a small hammer and a heavy "V" block which serves as an anvil to change the shape of patches as needed. Also, as part of the equipment, heavy asbestos gloves and clear vision face shields are supplied. Any operator or shift mechanic can apply one of these patches to stop leaks until the welder arrives. The patches do not constitute the final repair. Once they are welded into place, a heavier and larger plate is welded over the top.

IDEAS—Wanted

Plant engineers, superintendents, foremen!—Send in your own ideas on "how we do it around our refinery." Special gadgets, tools, shortcuts, safety schemes, etc. are suggested subjects. Please include photographs and drawings wherever available.

Material submitted for publication exclusively in PETROLEUM PROCESSING is paid for at the usual space rates. Send your contributions to:

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PETROLEUM PROCESSING
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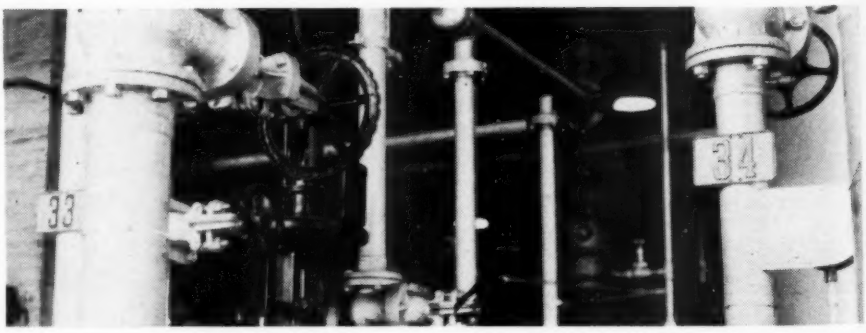
Cleveland 13, Ohio

Easily-read "License Plates" Give Help In Identification of Smaller Equipment

NUMBERED metal tags, similar to automobile or motor cycle license plates, help to eliminate confusion and mistakes by providing easy-to-read, positive symbols for pumps, compressors, and other smaller equipment at the Trenton, Mich., refinery of Socony-Vacuum Oil Co., Inc.

When an operator requests replacements for worn parts on a piece of equipment, the identification of the particular pump, for example, is simplified by the conspicuous sign. The "license" plate does not eliminate the use of conventional serial numbers or company inventory tags normally attached to the pump itself, but it is a rapid, definite means of instant identification. The opera-



Socony-Vacuum's "license" tags are attached to lines leading to the equipment they serve to identify

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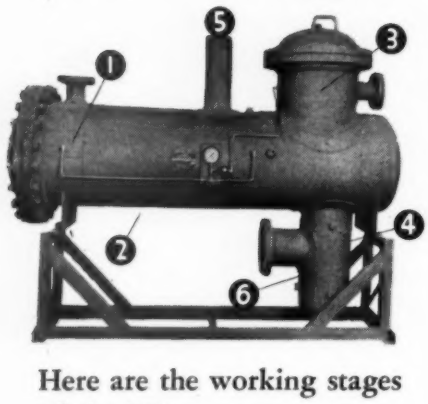

Here are the working stages of the FE:

1. 1st Stage — Pipe Scale, etc.
2. 2nd Stage—25 Microns or Larger
3. 3rd Stage—5 Microns or Smaller
4. Water Accumulator Chamber
5. Air Eliminator Mechanism
6. Steam or Electrical Immersion Heaters, if desired.

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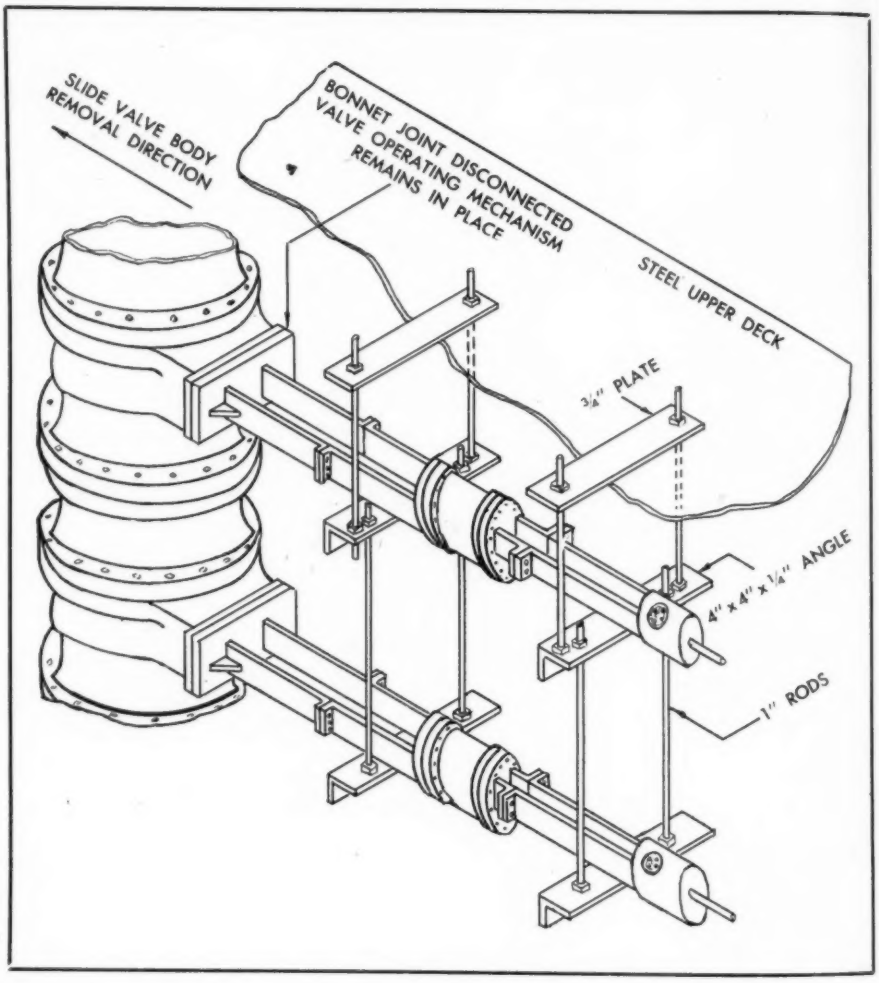
Removal of Slide Valves Is Simplified By Permanent Rigging on Fluid Unit


SLIDE VALVE BODY REMOVAL DIRECTION
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PERMANENTLY installed rigging, supports, and the like have saved many man-hours during unit turnarounds in Gulf Oil Corp.'s Philadelphia refinery. A number of these already have been described in an article on the turnaround of the Fluid catalytic cracking unit (PETROLEUM PROCESSING, Aug., 1947, p. 569).

One improvement designed and added since the last turnaround is a hanger arrangement for the large slide valve mechanisms on the Fluid unit catalyst carrier lines, and illustrated in simplified form above. Prior to this installation, an extensive and complex wooden platform had to be erected to support the mechanism whenever the valve body was disconnected and swung out of place on the previously installed overhead tramrail and pulley.

The hanger consists of 4 x 4 x ¼-in. angles supported by long bolts at each end of each valve mechanism. The long bolts hang from the floor of the deck above. The height of the mechanisms can be adjusted carefully by the nuts on the ends of the bolts. All the interconnecting small diameter piping serving the controls (not shown in the sketch) need not be disassembled. It is merely broken at the unions to allow the mechanism to be raised or lowered.

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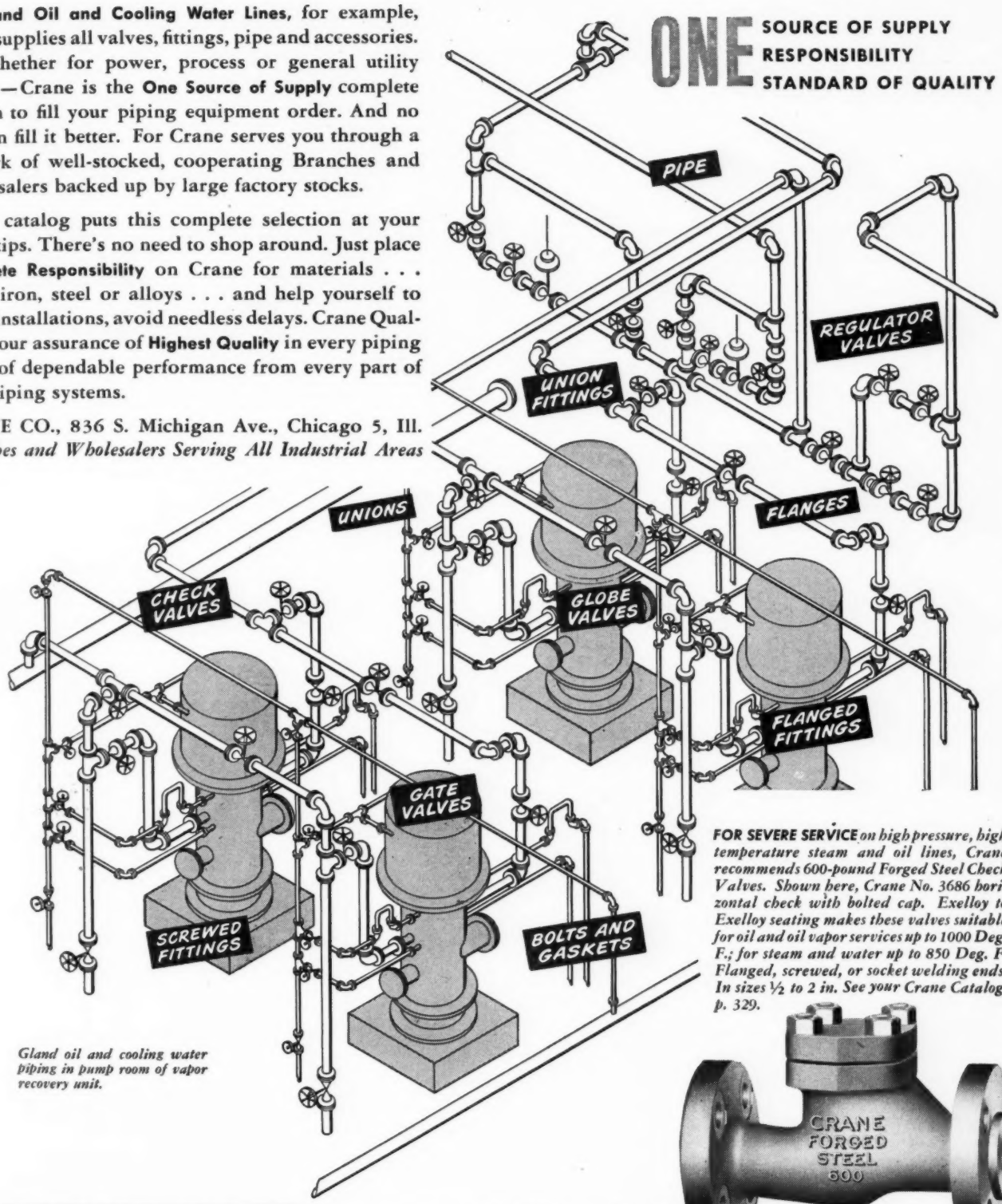

Gland oil and cooling water piping in pump room of vapor recovery unit.

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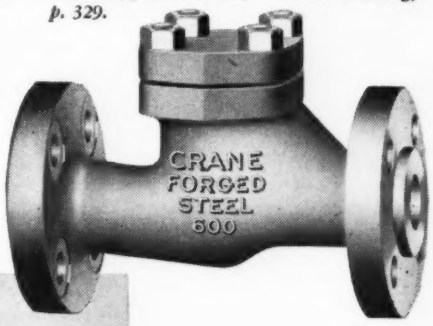

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Laboratory Practices

Aircraft Fuel Test Method More Rapid Through Use of Automatic Controllers

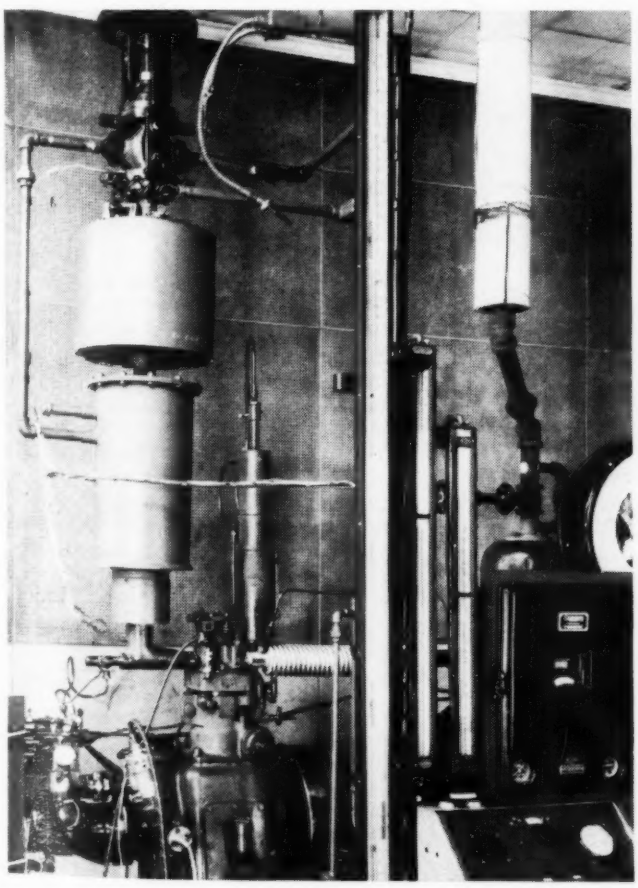
ENGINE testing of aircraft fuels under supercharged conditions with more precise control of test variables and considerable reduction in time has been accomplished by two automatic controller arrangements devised by engineers of the Beacon, N. Y., research laboratories of The Texas Co.[1]

The equipment consists of (1) a fuel-air ratio control and (2) an intake air temperature control. They make possible a direct comparison of anti-knock characteristics of various fuels throughout the entire range of fuel-air mixtures and temperatures. Time-consuming adjustments of both test variables are eliminated and tests which formerly required hours and even days, now can be completed in a matter of minutes, according to The Texas Co.

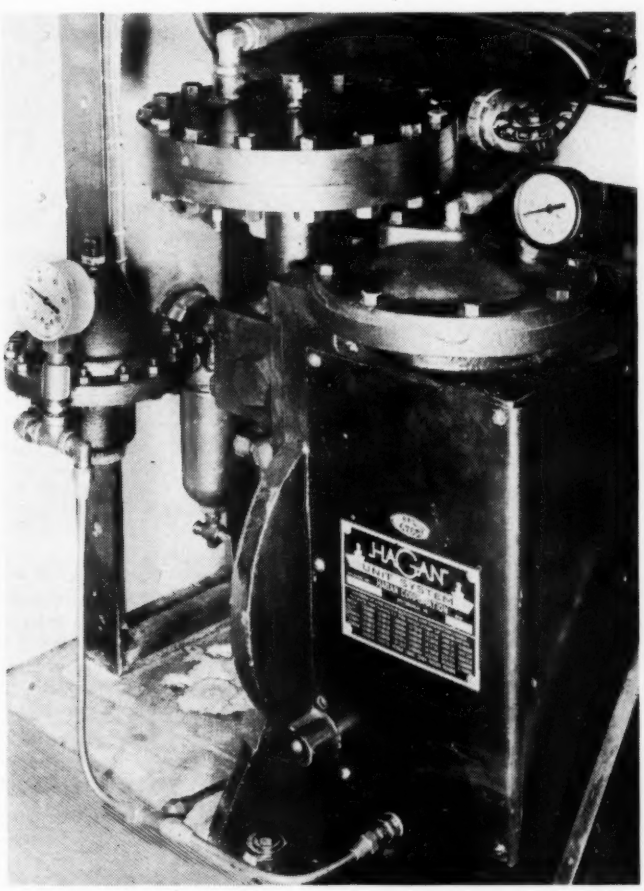
Fuel is delivered to the test engine in any selected relation to the amount of air consumed by means of the fuel-air ratio control mechanism. Air flows to the engine through a standard ASME Flow Measurement Code orifice. The pressure differential across this orifice is supplied to a variable ratio regulator. Operating on 60 psi. air pressure from the laboratories' air supply line, the regulator produces changes in its air pressure output that are a linear function of the orifice pressure differential.

The regulator output is impressed on one side of a ratio relay, whose action is similar to a see-saw with a variable fulcrum. Output pressure of the relay can be varied with its input in ratios from less than 1 to greater than 1, depending upon the position of the adjustable fulcrum. This relay is the control which permits changing the amount of fuel injected per unit of air consumed.

Output from the ratio relay is in turn piped to a micro-positioner at the fuel injection pump. The positioner takes a definite position for



Three-way valve (upper left) sends part of intake air through heater (just below valve) and balance through by-pass. Streams combine in surge tank (below heater chamber) before entering the engine



Actuated by pressure variations across an orifice in the intake air line, this variable ratio regulator maintains the fuel-air ratio in linear relationship to the amount of air being consumed in aircraft test engine

Sparkler Filters

SPARKLER horizontal plate FILTERS

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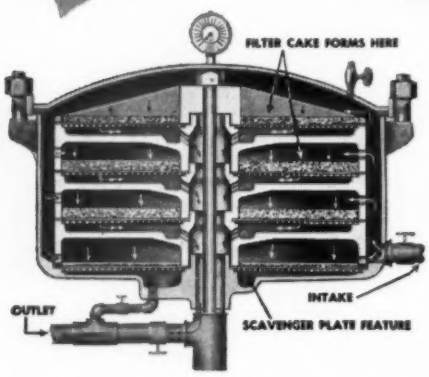

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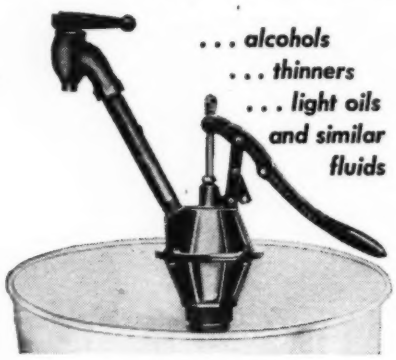

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any given value in air pressure. Since the ratio relay output air pressure varies linearly with the changes in air flow, the micropositioner likewise varies linearly with the flow of air to the engine. By knowing the temperature and absolute pressure of the air at the orifice, the test operator can translate this flow in terms of volume to flow in terms of weight.

The micropositioner moves the fuel injection pump rack. The volume and hence the weight of fuel injected by the pump is in linear relationship to the position of the pump rack. Everything being linear, the weight of fuel delivered to the engine and the weight of air consumed by the engine also are in a linear ratio. This so-called fuel-air ratio (weight ratio) can be set at any desired value by means of the control on the ratio relay. By suitable preliminary calculations, the setting of the relay takes care of differences between the specific gravities of various fuels. The ratio regulator, ratio relay, and micropositioner all are control instruments developed for the application at Beacon by the Hagan Corp. of Pittsburgh.

Engine air intake temperature is varied as desired by use of a three-way, diaphragm-motor controlled valve. Incoming air passes through the three-way valve, which divides the flow so that one portion goes over a finned electric heater within a small tank and the remainder by-passes the heater. The two streams rejoin in a surge tank where the air mixture comes to the desired temperature before entering the air-fuel mixing system. The proportions of air passing the heaters and air being by-passed vary with the position of the three-way valve.

The air temperature in the surge tank is measured by a thermocouple, which is connected to a Foxboro pneumatic controller on the air line operating the diaphragm motor on the three-way valve. The pneumatic controller can be adjusted to hold any value between 150 and 350° F. An additional temperature controller is utilized to limit the temperature of the heater fins to 740° F., preventing the heaters from burning out.

(1) "New Aircraft Fuel Tests Save Time, Texaco Says," NATIONAL PETROLEUM NEWS, 41, 13, p. 17 (March 30, 1949).

IDEAS—Wanted!

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Lab Kinks Editor
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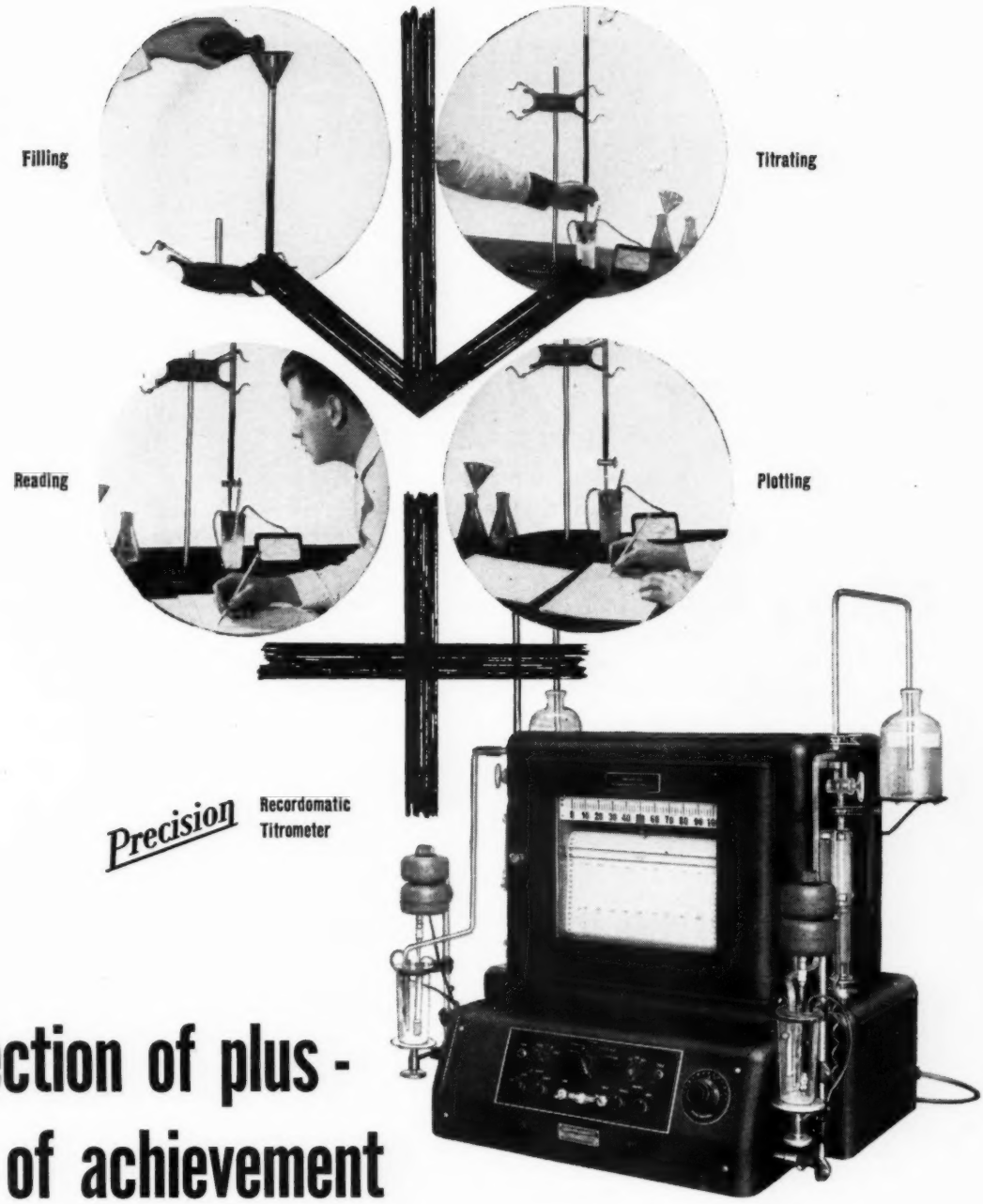

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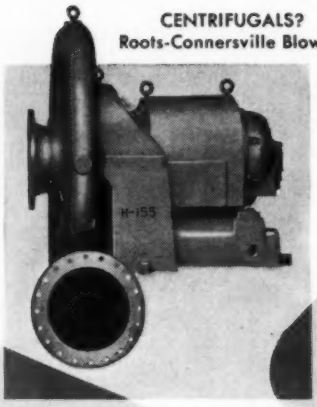
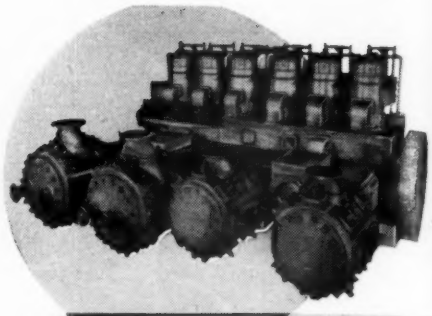
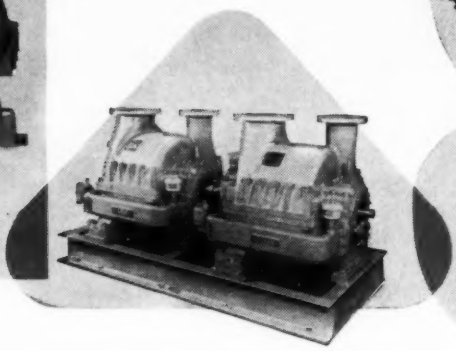
CENTRIFUGALS?
Roots-Connersville Blowers



RECIPROCATING?
Clark Bros. Compressors





CENTRIFUGALS?
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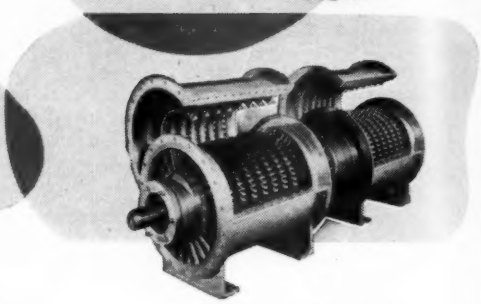
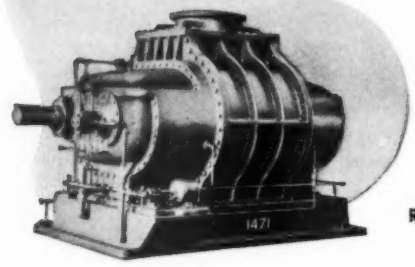


AXIAL FLOWS?
Clark Bros. Compressors



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Patent Trends in Petroleum Refining

By Peter J. Gaylor, Editor "The Technical Survey"

Patents Reveal New Methods Used to Improve Oxidation Resistance Properties of Lube Oils

RESISTANCE TO OXIDATION has become an important requirement for lubricating oils employed in internal combustion engines or in turbines. The case is particularly so with turbine oils which are generally used for years before they are replaced.

Many operations in the refinery tend to decrease oxidation resistance, and processes have been developed, wherein critical conditions are employed, not only for eliminating this possibility but also for improving considerably the oxidation resistance. Overtreating and undertreating generally give unsatisfactory results, in the absence of additives to overcome the adverse properties obtained.

In modern practice, lubricating oils are subjected to solvent and acid treatments and also with clay. Bauxite treatment also has been employed. A Sonneborn patent(1) specifies contacting at 100°-300° F. with bauxite activated at 600°-1600° F. and having a particle size of 30-60 mesh, the treatment serving mainly to remove at least 3% of asphaltic-forming constituents. Percolation filtering with bauxite has been in progress in the Mid-Continent and the East, as reflected by a 24% drop in fuller's earth consumption for 1938. However, the Georgia-Florida type of fuller's earth has been improved some 20% in adsorptive power by an extrusion process(2), and this may be the first real step towards improving the properties of clays to meet the new competition.

Combine Discoloration, Distillation

A new departure introduced some time ago by Standard of California(2) is said to combine contact decolorization and fractional distillation in one continuous process. A portion of the lube stock to the fractionator is sent to a mixing tank where the right amount of clay is added. The clay and oil mixture is then put through a heat exchanger, then a pipe heater, and finally charged into a fractionating tower at around 675° F. The various cuts are taken from the tower, and heavy bottoms containing the clay are sent to a surge tank and then to a vacuum filter where the spent clay is removed.

Apparently such a process was developed by the Filtrol Corp.(3) and is adapted to a lube oil vacuum rerun unit employing a solvent treated long residuum, using 0.125 lbs. clay per gallon of charge. Color of the stock is dropped from 4 to about 1 or 1.5.

Union Oil has effected treatment of lubricating oil by diluting the latter with liquefied propane under sufficient pressure to maintain the liquid phase, followed by acid and clay treatments, while in solution(4). Asphalt or wax can be removed before the acid treatment.

At its Wellsville plant, Sinclair Refining Co. employs continuous lube oil decolorizing and solvent clay reactivating, wherein the oil is contacted with Magnesol in presence of 260°-380° F. b. pt. Pennsylvania crude naphtha(5).

Among other new innovations in this field is the decolorizing of oils by Indiana with clay wetted with sulfuric acid(6), and the adding to the oil (by Atlantic Refining Co.) of a small amount of finely divided mica and talc, followed by contacting with sulfuric acid and separation of sludge formed(7). One patent issued to Atlantic Refining(8) specified contacting the oil with sulfuric acid containing a small amount of finely divided elemental sulfur.

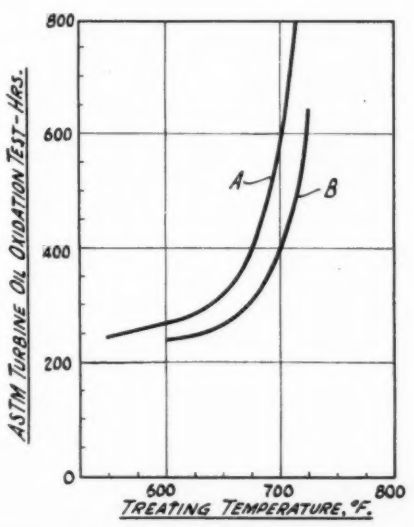

Fig. 1—Effect of treating temperature on stability

Turbine Oils

Several recently issued patents to The Texas Co. disclose the preparation of oxidation-resistant turbine oils. One of them(9) specifies contacting the oil with Super Filtrol or Lena Clay, in powdered form, at 650°-725° F. with a time of reaction of about 0.5-2 hrs. There appears to be a critical temperature for each stock, beyond which a small increase in temperature results in very greatly increased stability, such temperatures being 625°-675° F.

If temperature is unduly increased, coking is apt to occur and mechanical difficulties such as a tendency for the clay to settle out may be encountered. Also, thermal cracking may occur at the expense of the desired selective catalytic conversion. The upper limit is about 750° F., and the response of paraffinic stocks is better than that of naphthenic oils. Yields of around 65-80% of oxidation-stable oils of the same viscosity as that of the oil treated are possible.

It has been found, for example, that the sequence in which the catalytic treatment is applied in respect to other refining steps is of a critical nature. In the case of turbine oils, the catalytic treatment must be applied after the oil has been subjected to other refining treatments, such as solvent refining and acid treating.

As can be seen from Fig. 1, the stability of the treated oil (as determined by the ASTM Turbine Oil Oxidation Test), increases with increase in treating temperature. The oil is a naphthenic pale oil having a viscosity of 500/100° F. (Say. Univ.), treatment being with 10% by weight of Super Filtrol. Curve *A* represents a contact time of 63 min. while *B* is for 32 min. For each curve there is a critical temperature beyond which a small increase in temperature results in greatly increased stability.

Fig. 2 shows the effect of different

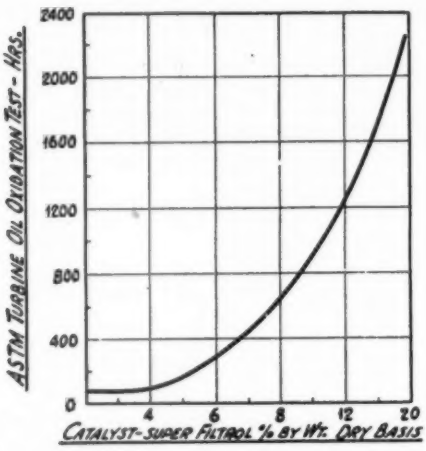

Fig. 2—Effect of amount of treating clay on stability

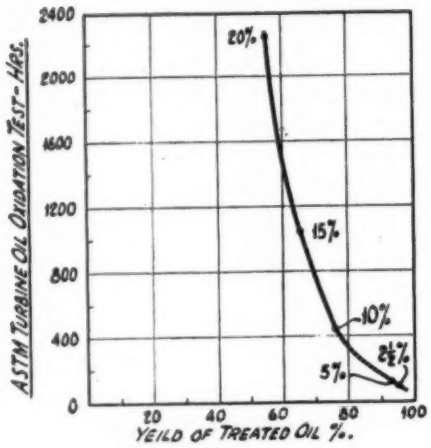

Fig. 3—Relationship between oil yield and stability

amounts of clay on the oxidation stability. In this case, the 500 Pale Oil was contacted with Super Filtrol at 700° F. for 32 minutes. It will be observed that from a point approximating 8-10% catalyst, the curve rises very steeply. Practical considerations involved in handling the mixture of oil and catalyst will generally place the upper limit of clay catalyst at around 20%.

The relation between yield of product and oxidation stability improvement, when using different amounts of catalyst, is indicated in Fig. 3. In this case, the 500 Pale Stock was treated with Super Filtrol at 710° F. for 32 min., using varying proportions of clay.

There is a difference in the oxidation characteristics of these treated oils when compared with inhibited oils, as can be observed from Fig. 4 in which curve *C* designates the clay treated oil, while curve *D* is a typical curve of a turbine oil, not treated with clay, in the manner heretofore outlined, but inhibited with tetramethyl diamino diphenyl methane. It will be noted that the inhibited oil had a long induction period of some 900 hrs., after which the acidity increased very rapidly. In curve *C* (which represents the same base stock), the treated oil had a short induction period of about 250 hrs., after which acidity rose linearly with time.

In Fig. 5 is shown a curve of an inhibited treated oil, namely, the oil used for Curve *C* plus added inhibitor (the same amine). It will be observed that the addition of inhibitor increased the induction period to 750 hrs. and, beyond that period, the increase in acidity is quite gradual, with the total life being greatly extended over that of the oils in Curve *D* or *C*.

Another patent issued to Texas Co.(10) discloses that the improvement in oxidation stability by such clay treatment is generally greater in the higher boiling or higher viscosity components of the treated oil. To show this effect, a 500 Pale Oil was fractionated under vacuum distillation to produce 10% distillate cuts and a residual or bottoms fraction. Certain of these fractions including the 20-30%, the 40-50%, the 60-70%, the 80-90% fractions of the distillate and the undistilled bottoms were each separately treated with 10% by weight of Super Filtrol at 600° F. for 1.5 hrs.

The 10% fractions and the bottoms fraction were plotted against the hours required in the oxidation test to reach a neutralization number of 2 and it was noted that the stripped products have a considerably longer test life than the unstripped fractions. It is evident that considerably longer oxidation test life can be obtained by clay treatment of the fractions than by treating the whole oil stock in one operation. In actual operation, the oil is fractionated into a plurality of cuts and these cuts are subjected to the catalytic cracking in presence of clay, after which they are stripped and blended to produce a high quality lubricating oil.

References

(1) U. S. Pat. 2,170,628 (L. Sonneborn Sons).
(2) Fitzgerald, *Petroleum Refiner* 1/49 p. 45.
(3) Moore & Gwyn, *Petro. Refiner*, 1939, No. 2, p. 45.
(4) U. S. Pat. 2,191,091 (Union Oil).
(5) Chenault, API Meeting, San Francisco 11/6/41.
(6) U. S. Pat. 2,263,102 (S. O. Indiana).
(7) U. S. Pat. 2,282,033 (Atlantic Refg. Co.).
(8) U. S. Pat. 2,286,343 (Atlantic Refg. Co.).
(9) U. S. Pat. 2,461,453 (Texas Co.)
(10) U. S. Pat. 2,461,454 (Texas Co.).

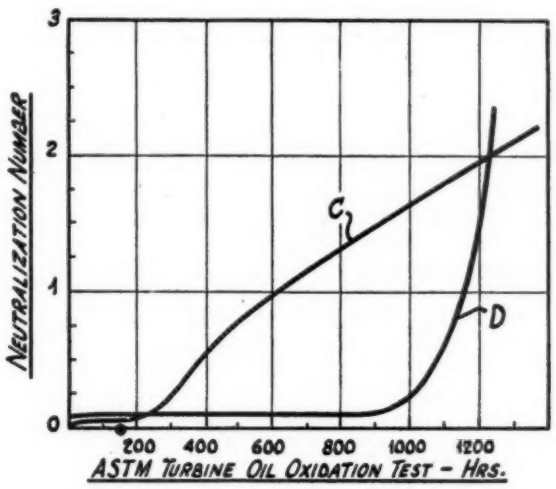

Fig. 4—Comparison of clay-treated and inhibited oils

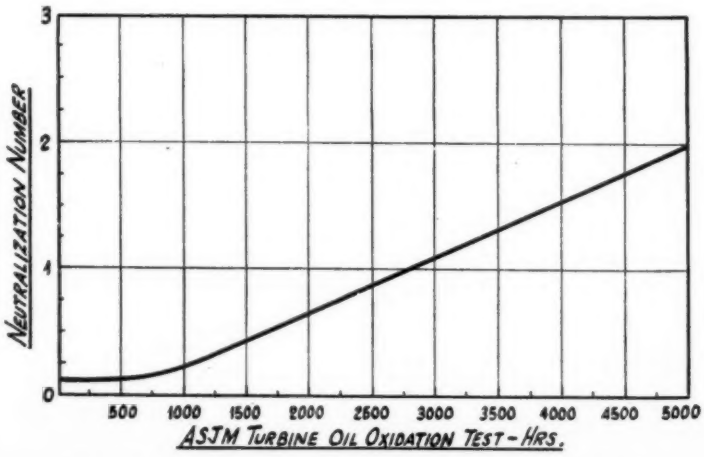

Fig. 5—Improvement by inhibiting clay-treated oil

For Simplicity, Ease of Control and High Yield in Organic Syntheses

Try Hooker Sulfuryl Chloride—

Sulfuryl Chloride has great potentialities in organic synthesis for these reasons: (1) reactions are simple (2) they are easy to control (3) excellent yields generally result (4) no special equipment is needed (5) a variety of reactions is possible.

Chlorination of Aromatics and Aliphatics

Sulfuryl Chloride reacts with both aromatic compounds and aliphatic compounds to form many interesting compounds. Advantages of sulfuryl chloride as a chlorinating agent are:

1. The heat of chlorination using sulfuryl chloride is far less than that using elemental chlorine.
2. It is possible by using different catalysts, reacting at different temperatures and by carefully controlling proportions of reactants to chlorinate selectively.

Sulfonation of Aromatic and Aliphatic Compounds

By varying the conditions of reaction, sulfuryl chloride can be used for sulfonation of the aromatic nucleus. Sulfuryl chloride derivatives of benzene, toluene, xylene, mesitylene are some of the products obtained.

The introduction of the sulfuryl chloride group into aliphatic compounds is accomplished in the presence of light and a suitable catalyst. A rapid vigorous reaction occurs with the formation of alkyl sulfonyl chlorides and yields as high as 70% are reported.

Acylation

Aliphatic alcohols react with sulfuryl chloride to form chlorsulfonates and with an excess of alcohol the reaction may proceed to form dialkyl sulfate or alkyl sulfuric acid.

Similar reactions take place with aliphatic amines and under proper conditions it acts as an acylating agent with aromatic amines.

Literature on this versatile chemical also reports the formation of acid anhydrides and chlorides and esters.

Hooker Sulfuryl Chloride is a particularly pure product with a 99% minimum sulfuryl chloride content. Additional information on Hooker Sulfuryl Chloride is available in Hooker Technical Data Sheet 717, Hooker Bulletin 328A, "Chlorinating Agents" and Bulletin 330, "Sulfuryl Chloride in Organic Chemistry." Write for copies on your business letterhead.

HOOKER RESEARCH Presents

BENZOTRIFLUORIDE
(Trifluoromethylbenzene)

Molecular Weight	146.1
Freezing Range	−28.5° to −29.5° C
Boiling Range (ASTM, 98%)	2.5° including 101° C
Specific Gravity 15.5°/15.5° C	1.197
Refractive Index n20/D	1.4145

This new product of Hooker Research is another of the fluorides whose properties indicate its usefulness as a chemical, dyestuff, and pharmaceutical intermediate, as a solvent or dielectric fluid and in the manufacture of bactericidal products.

Benzotrifluoride is a colorless aromatic liquid. Its thermal stability is excellent, the CF_3 group not being attacked at 350° C in the presence of iron or copper. It is completely miscible with most common solvents. The trifluoromethyl group is strongly meta directing.

Hooker benzotrifluoride is at present available in pilot plant quantities. Technical Data Sheet No. 350A describes more completely its physical and chemical properties. Please use your company letterhead when requesting sample or literature.

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Erosion of Seat Is Eliminated With New Rotary Plug Valve

In addition to the improved rotary plug valve described below; this month's review of new and improved devices used in petroleum processing and handling operations on which patents have been issued recently includes:

- **Lube test unit saves hours compared to engine method**
- **Pipe ells marked accurately by means of simple scriber**

ADAPTED FOR SERVICE on gasoline, high-pressure steam, or salt water lines, a plug valve has been designed in which the plug cannot be rotated when in contact with the valve seat. This is said to prevent rapid erosion of the seat, usually met with in conventional valves of this type, wherein the plug is unseated when in the "open" position.

Shown in the sketch in Fig. 1, the valve operates as follows: Assuming it to be closed and seated as illustrated, handwheel 56 is turned clockwise. Plug 32 and stem 40 are prevented from rotating by the transverse ribs 22 in the bottom of the body 10 with which slots 38 in the bottom of plug are engaged. Bushing 52 rotates with the handwheel and because its threads which engage stem 40 are right-handed, clockwise rotation of the handwheel lifts the plug from its seat.

At the time the plug clears ribs 22, shoulder 46 strikes the underside of bushing 52; then the plug 32 and handwheel 56 rotate as a unit through an angle of 90° or until pawl 62 drops over the edge of the next of four teeth on cam 60. At that point, the valve is open. The plug can then be seated by turning the handwheel counterclockwise until ribs 22 again engage slots 38, and the valve seats and the plug return to tight contact with each other. To close the valve the entire operation is repeated.

U. S. 2,464,123, issued March 8, 1949, to W. T. Downing and S. P. Johnson.

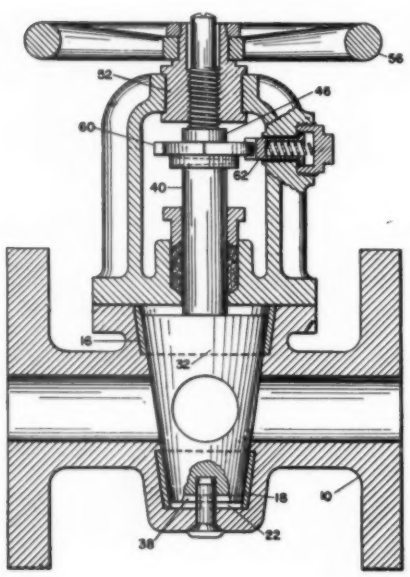

Fig. 1—Plug 32 remains in tight contact with seats 16 and 18 in both closed and open positions of improved plug valve (U.S. 2,464,123)

Lube Test Unit Saves Hours Compared to Engine Method

CLOSE CORRELATION with results from the standard Chevrolet engine test for lubricating oils is said to be obtained in a simplified apparatus which eliminates the need for an actual automobile engine. Analyses were found to be within 10% of those obtained in the Chevrolet method. The 36-hr. run can be duplicated in 10 hrs. and the 72-hr. run in 20 hrs., it is reported.

The apparatus is illustrated in Fig. 2. It comprises a glass container 10 inserted in any suitable heating means, such as a heat-conducting solid metal 20 containing an electric resistance 64. Filtered and dried air is admitted through glass injector 12 at the bottom of the container 10.

A test piece 46 receives frictional wear from a hardened steel rod 56, which fits into holder 52 at the lower end of rotating shaft 24 within the inner tube assembly 16. It is driven by any suitable means connected to pulley 60. The oil under test is poured into container 10 so as to submerge completely the lower end of tube 16.

Rotational speed of rod 56 against test piece 46, the flow of air up through container 10, and the temperature of the oil sample can all be closely controlled so as to duplicate with precision any given conditions as encountered in an actual engine test. Among the advantages cited for the apparatus in addition to its obvious low initial cost are 1) speed of the test run, 2) no need for expensive disassembly of actual automobile engine, 3) flexibility of control of test conditions, and (4) possibility of running as many such small units as possible for simultaneous testing of several samples of oil.

Service properties of the oil under test are found by 1) determining the loss in weight of the test piece, 2) visually rating the lacquering properties by examining the coating deposited on the outer surface of sleeve 16, 3) obtaining a visual sludge rating by examining the insoluble materials and used oil coated on the glass walls of container 10, and 4) determining the usual properties of the remaining used oil by testing for such values as pentane insolubles, benzene

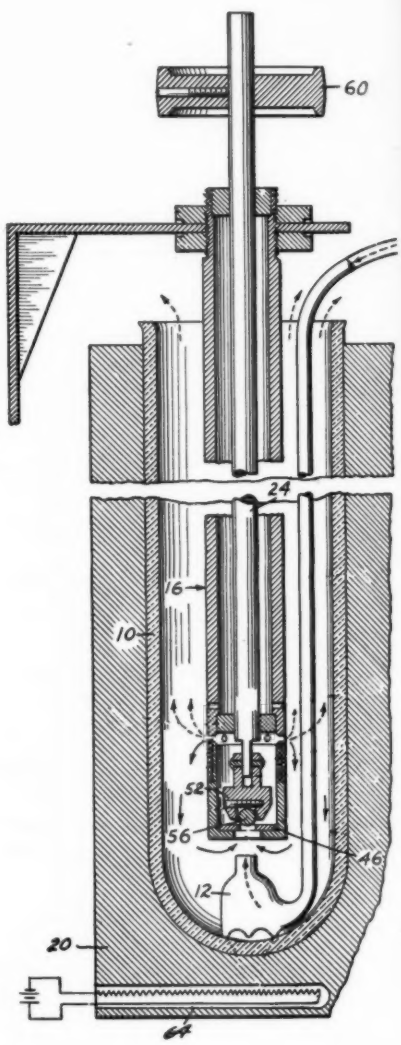

Fig. 2—Simplified, inexpensive apparatus for testing lube oils closely duplicates standard Chevrolet engine test results (U. S. 2,464,233)

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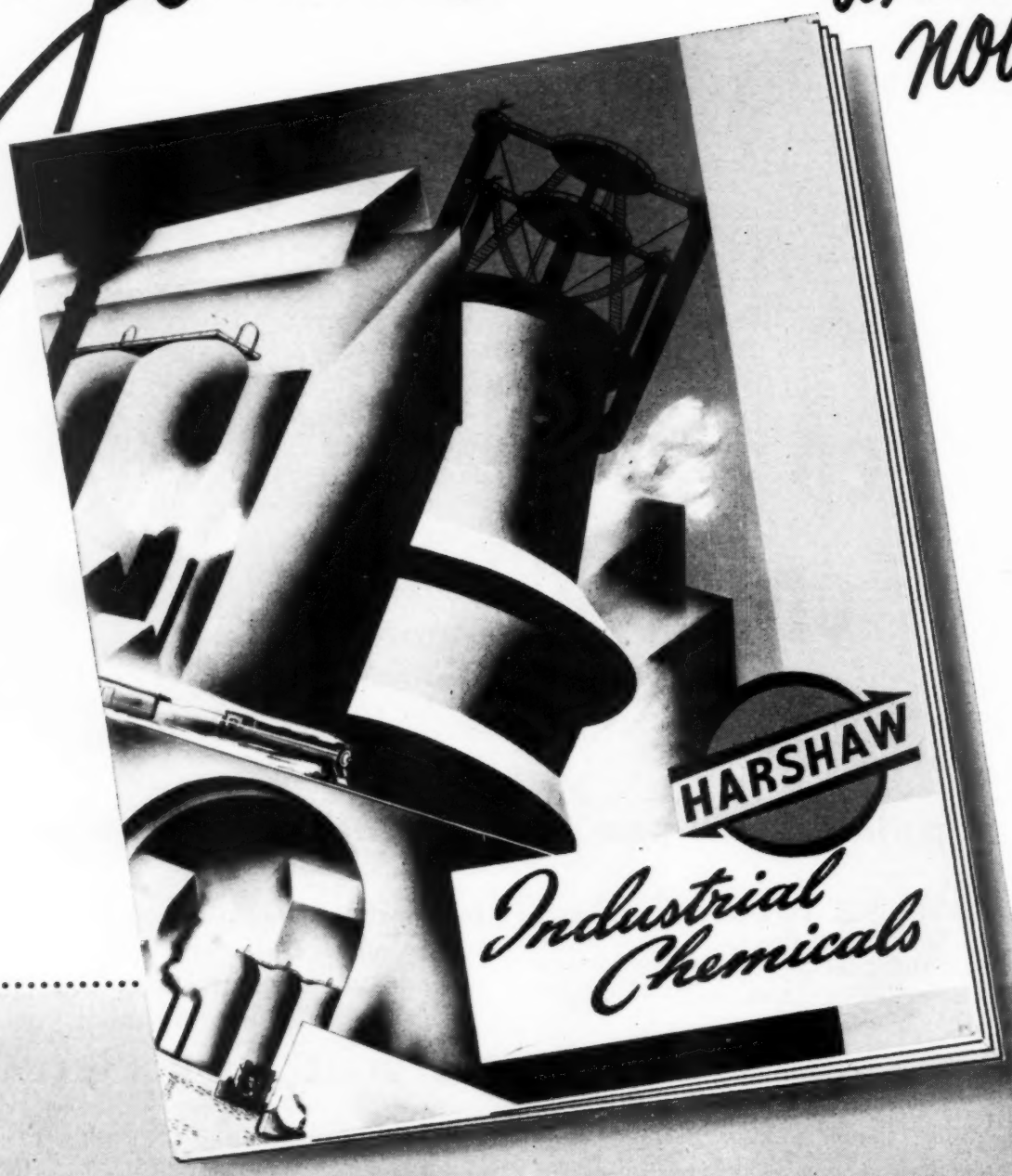

This 32-page book alphabetically lists all chemicals available through Harshaw, relates the history of the Company and describes Harshaw's major activities. Write for a copy.

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solubles, viscosity increase, and neutralization and saponification numbers.

U. S. 2,464,233, issued March 15, 1949, to E. C. Hughes, J. D. Bartleson, Margaret L. Sunday, and M. M. Fink, assignors to Standard Oil Co. (Ohio).

Pipe Ells Marked Accurately By Means of Simple Scriber

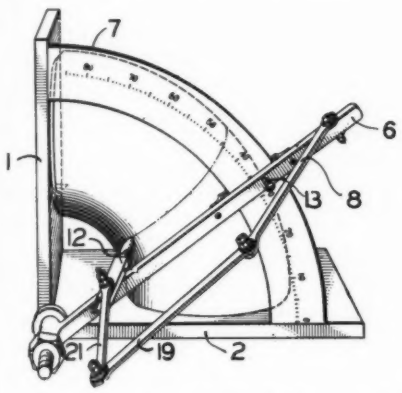

Fig. 3—Pipe ell marking device can be set at any angle within a 90° arc (U. S. 2,464,444)

PIPE ELBOWS or tube turns can be quickly and accurately marked off for any desired angle prior to cutting with the simple, protractor device illustrated in Fig. 3. In use, the pipe ell is placed with one face flush with plate 1 and the other face flush with plate 2. Swinging arm 6 is then set at the required angle as indicated on protractor 7 and secured by tightening set screw 13.

The flexible arm which holds marking chalk 12, formed by jointed segments 8, 19, and 21, is so constructed that the movement of the chalk remains in the same plane as the indicating side of arm 6, and also is free to move around the entire surface of the pipe ell.

U. S. 2,464,444, issued March 15, 1949, to Darwin I. Gantz, Wilmington, Calif.

Other Recent Patents

Space does not permit the complete review of all patents issued recently on equipment for the petroleum processing industry. Following, however, are brief abstracts of those with the greatest interest:

Floating Roof Tank Seal in which the bottom of the shoe is kept immersed in the stored liquid by means of a float that pushes the shoe up-

BUY....

CALITE HEAT ENDURING CASTINGS

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STANDARD SPECIFICATION NO. 10-38

Heat Enduring Castings
For Industrial Furnace Construction
Grade "F"

CHEMICAL COMPOSITION:

(a) The castings shall conform to the following requirements as to chemical composition:

	GRADE "F"
Chromium, per cent	25.0-28.0
Nickel, per cent	10.0-12.0
Manganese, per cent	0.50-1.25
Silicon, per cent	0.25-1.75
Sulphur, maximum per cent	0.05
Phosphorus, maximum per cent	0.05
Carbon	Within limits of Paragraph 4 (c)

(b) The chemical limits for all other added alloying elements, such as molybdenum, titanium and nitrogen, shall be specified by the manufacturer. The material shall conform therewith.

CREEP STRESS AND CERTIFICATE:

(a) The indicated creep rate of the material shall not exceed 1% in 10,000 hours when stressed by a tensile load not less than the following:

TEMP. °F.	STRESS PER SQ. IN. 1% CREEP IN 10,000 HOURS GRADE "F"
1400°	4200#
1500°	3700#
1600°	3200#
1700°	2600#
1800°	1950#

(b) Manufacturer shall submit standard creep data and residual physical properties made on material of his own manufacture and certified by an ACCREDITED LABORATORY. The chemical analysis of the creep test specimens shall be reported, including nitrogen content and any other special alloying elements.

TENSION TEST FOR DUCTILITY AFTER HEATING:

(a) Each heat shall conform to the following requirements as to tensile properties after the specimen has been subjected to a temperature of 1400° F. for 24 hours and furnace cooled to 400° F. Test shall be made at room temperature.

	GRADE "F"
Tensile Strength, min.lb./sq.in.	80,000
Yield Sfrength, min.lb./sq.in.	35,000
Elongation in 2", min. per cent	9.0

Copy of complete specification will be mailed upon request

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HEAT ENDURING AND CORROSION RESISTING METALS.
CALITE ALLOY CASTINGS — CALORIZED STEELS.

WILKINSBURG STATION PITTSBURGH 21, PA.

wardly and outwardly against the tank shell. U. S. 2,464,804, issued March 22, 1949, to Fred L. Goldsby and Clifford M. Orr, assignors to Chicago Bridge & Iron Co.

Combination Centrifugal - Vacuum Pump in which the vacuum pump is used as a priming means for the centrifugal and is automatically disengaged as soon as prime has been obtained, eliminating the need for driving the vacuum pump throughout the operating period of the centrifugal. U. S. 2,464,144, issued March 8, 1949, to James W. McConaghy, assignor to Ingersoll-Rand Co.

Dropping Funnel for closed-vessel reactions, in which feed is maintained continuously at proper rate of flow and complete seal is maintained between reaction chamber and outer atmosphere. U. S. 2,462,556, issued February 22, 1949, to Walter Rosenthal, New York, N. Y.

Distillation Retort for Oil Shales, tar-sands, and the like; comprising a furnace type housing through which a bank of horizontal screw conveyors carry the solid hydrocarbonaceous materials, and including an arrangement for recycling partially spent materials. U. S. 2,463,693, issued March 8, 1949, to Lyman C. Huff, assignor to Universal Oil Products Co.

Corrosion-resistant Pipe utilizing a porcelain, or similar, lining within an ordinary steel outer shell with a second inner lining of lead placed between steel and porcelain, the lead being extended so as to serve as flange gasketing also. U. S. 2,464,487, issued March 15, 1949, to R. E. Chappell, C. M. Beamer, and R. B. Duff, assignors to Standard Oil Development Co.

Catalytic Alkylation Reactor of the so-called "Votator" type; using a large number of hollow pins projecting from an internal eccentric cylinder which revolves at high speed, from which pins the olefin or other alkylating agent is dispersed by centrifugal force so as to effect efficient mixing. U. S. 2,463,262, issued March 1, 1949, to Arthur R. Goldsby, assignor to Texaco Development Co.

Fluid Catalytic Regenerator incorporating in a single unit the kiln proper, a conventional cyclone type separator, a heat recovery zone, and a flue gas scrubbing zone for recovery of the catalyst fines in the form of a slurry with incoming reactants. U. S. 2,462,193, issued February 22, 1949, to William E. Hulsberg, assignor to Universal Oil Products Co.

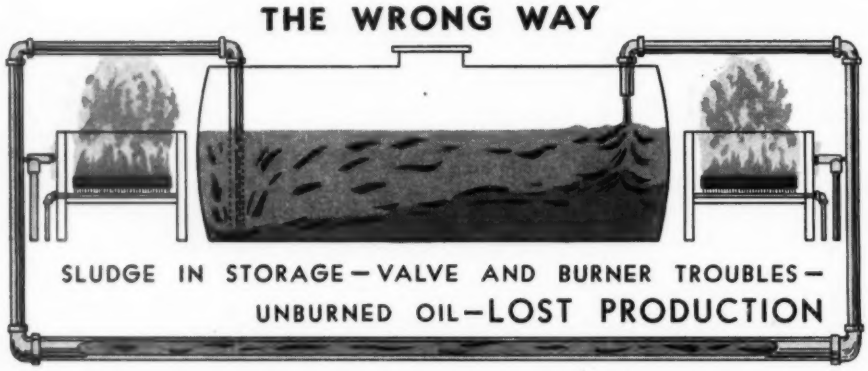
Moving Bed Catalytic Cracking unit employing in place of mechanical elevators: 1) the fluid reactants as a liquid or gas lift for regenerated catalyst, and 2) the regenerating gases as a gas lift for the spent catalyst. U. S. 2,463,623, issued March 8, 1949, to Lyman C. Huff, assignor to Universal Oil Products Co.

Automatic Controls for a complete process using an infra-red spectrometer for direct regulation of process conditions in relationship to changes in chemical composition as detected by the spectrometer. U. S. 2,462,995, issued March 1, 1949, to Otto F. Ritzmann, assignor to Gulf Oil Corp.

Constant Temperature Bath liquid circulator designed specifically for use in small size apparatus where close control is essential, as for example in refractometers; the device comprising both an agitator and a small circulating pump. U. S. 2,460,757, issued February 1, 1949, to William Kurz, assignor to Precision Scientific Co., Chicago, Ill.

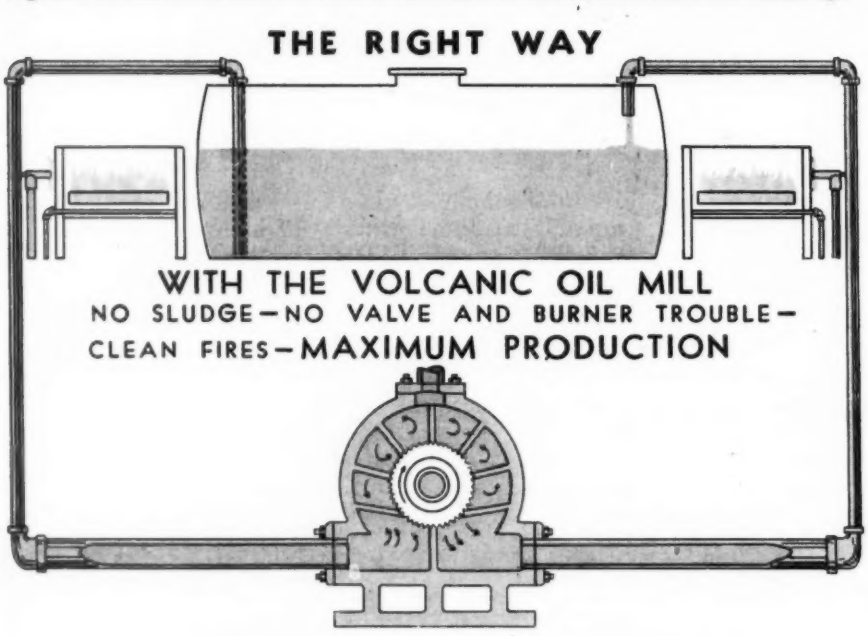
TWO WAYS OF BURNING OIL

THE WRONG WAY



SLUDGE IN STORAGE—VALVE AND BURNER TROUBLES—
UNBURNED OIL—LOST PRODUCTION

THE RIGHT WAY



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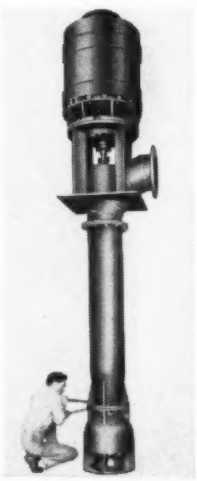
What's New!

EQUIPMENT . . . MATERIALS . . . PROCESSES . . . LITERATURE

Reviewed by WILLIAM C. UHL, Equipment Editor

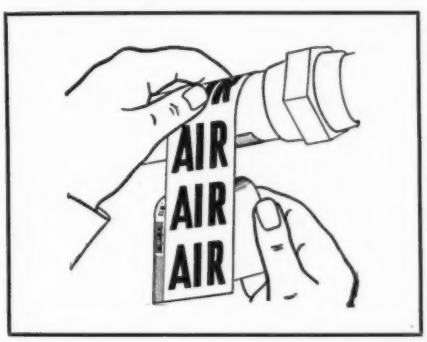
1—Cooling Tower Pump



A new line of "BJ" single and multi-stage vertical circulating pumps, designed primarily for cooling towers, are also suitable to many heat exchange applications where medium to high capacity pumping is indicated. The smaller sizes, from 5 to 12-in., are furnished in capacities from 20 to 3000 gpm at heads required. The larger sizes, above 12-in., are available in capacities of 1500 gpm. and up at heads required. Lead-impregnated bronze bearings assure long wear. The suction bell is grease-packed; all other bearings are water-lubricated. Byron Jackson Co.

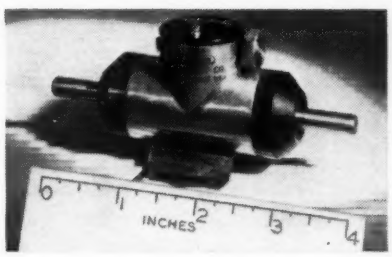
2—Pipe Marking Tape

Self-adhesive, "Quik-Label" Pipe Markers for identification of materials carried in pipes are designed to conform to American Standards Association Standard No. A13, "Identification of Piping Systems." Each marker is 2¼ in. wide by 9 in. long and comes mounted on a card 2¾ x 9 in. Standard A13 establishes five basic background colors for classifying the major types of materials carried in pipe, with the names of the specific material superimposed on the proper background color. The manufacturer states the labels can be read at up to 75 ft. with illumination from an ordinary flashlight. Labels are weather and water-proof. Standard labels in stock cover 150 materials, including chemicals, hydrocarbon liquids and gases, water, etc. Also available are conduit markers for line voltages from 110 to 4800. W. H. Brady Co.



3—Miniature Speed Changer

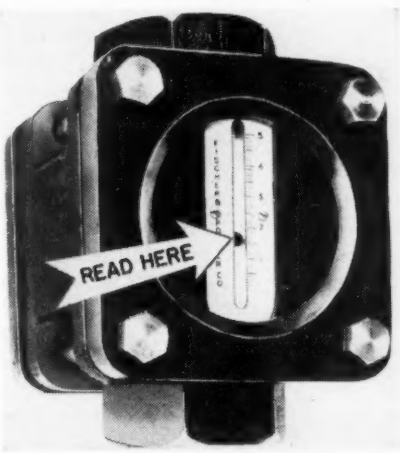
The "Metron" Miniature Variable-Ratio Speed Changer, which weighs less than 6 oz., and will fit in the hand, can deliver up to 70 ounce-inches torque and 0.025 hp. Possible applications include laboratory apparatus, recording, indicating, or controlling instruments, and similar mechanisms. Ratio of input to output speeds is infinitely adjustable between 1:6 increase and 6:1 decrease, with a total range of 36:1. Ratio setting is indicated on a dial and pointer. The adjusting knob has a friction drag to prevent ratio wander. Maximum output torque, is obtainable at zero speed and operating speeds to 20,000 rpm. are practical, it is said. Internal construction employs rollers, contacting discs on input and output shafts. Speed



is adjusted by changing the radius at which the rollers make contact. Metron Instrument Co.

4—Magnetic Flowmeter

The "Magna-Sight" flow guide is equally useful for clear and opaque streams. The instrument uses the Fischer & Porter standard "Bull's Eye" body with a fixed diameter oririce at its vertical inlet. A tapered plug is suspended in the fluid stream within the orifice. A permanent magnet in the tapered plug causes an external steel ball to move against a calibrated flow scale. The rear enclosure is a heavy Herculite glass window, permitting visual observation of the fluid. The guides are made in eight sizes from ¾ to 4 in., screwed or flanged fittings, and measure rates from 3.5 to 250 gpm. Minimum measurable rate is 1/10 maximum. Fischer & Porter Co.



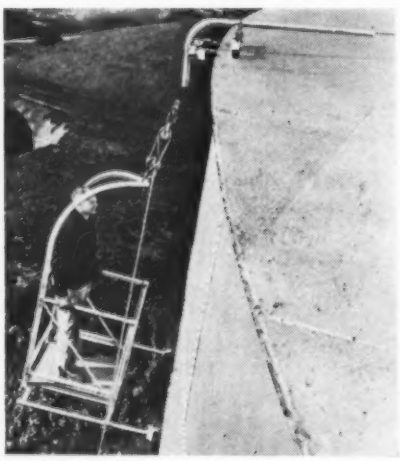
More "What's New!" Items, p. 586

For More Information

Use one of the attached reply cards to request additional information or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the rest of the card, and drop it in the mail. No postage required.

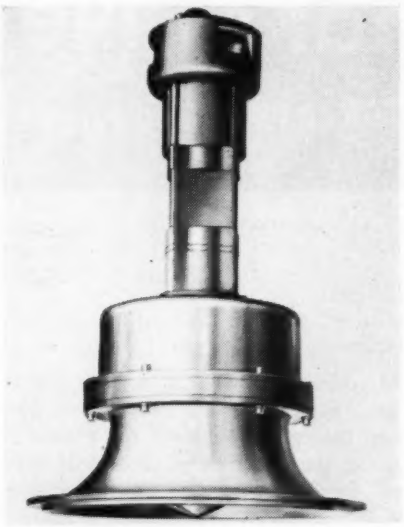
5—Tank Maintenance Cage

The "Roll-Around" Safety Cage, constructed of non-sparking aluminum alloys, weighs only 70 lbs. and can be carried by one man to the top of the storage tank. In use, a wire cable is fastened to an eye-bolt in the center of the tank roof, threaded through the curved tube of the Roll-Around, and fastened to a block-and-tackle or power-driven hoist. One set of casters rolls on the tank roof and are of a locking type to prevent lateral movement. The bracket on which the side casters is mounted is adjustable up and down in increments of ½ in. On the cage itself, the operator's safety belt is fastened to the rear guard rail. The arched support construction permits free movement of pole-type spray guns. Casters on the cage proper also are the locking type, and are mounted on legs with 24-in. adjustment. Casters will roll in both vertical and horizontal direction, as required. Up-Right Scaffolds.



6—"Siren" Dust Separator

Said to be the first high intensity sound generator offered for gas phase use, the Model U-4 Sonic Generator is employed to produce sonic energy, useful for difficult dust, fume, and mist collection problems. The sound waves effect agglomeration of extremely fine particles in a gas stream. Aggregates thus built up may then be efficiently collected by conventional cyclone separators. The Model U-4 provides frequencies from 500 to 22,000 cycles per sec., with an output over 300 watts, at intensity levels up to 165 decibels. They have been applied successfully in Union Oil Co.'s shale oil plant (PETROLEUM PROCESSING) December, 1948, p. 1187). Drive is a 12,500 rpm., 1.5 hp., explosion-proof electric motor, 115 volts, 50-60 cycles. A.C. Model U-4 will handle gas streams up to and over 1500 cfm. For larger volumes, up to 50,000 cfm., a Model U-3 is offered. The Ultrasonic Corp.

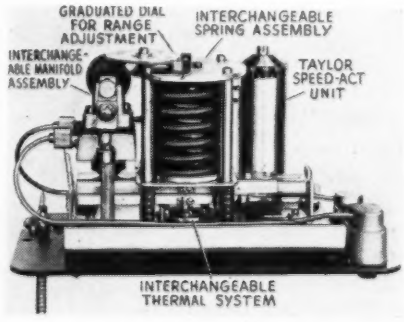


7—Corrosion Protection

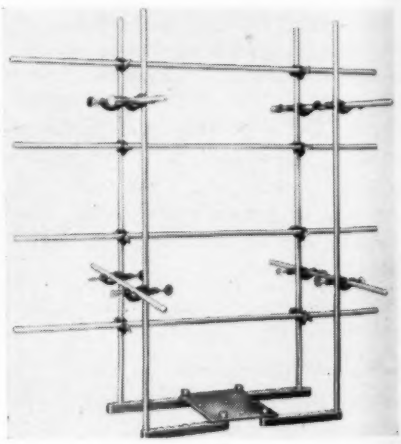
Cathodic protection against corrosion in heat exchangers, piping, and similar equipment can be obtained by use of the new "Cor-In" Corrosion Inhibitor Zinc Rods, which are fitted with standard pipe-plug ends and can be screwed directly into the equipment needing protection. The rods come in diameters of ⅜, ½, ⅝, ¾, and 1-in., with lengths up to 12 in. Rotometals, Inc.

8—Temperature Transmitter

The newly-developed "Transaire with Speed-Act" is a force-balance type pneumatic temperature transmitter designed particularly for remote location of the controlling, recording, or indicating device; and where it is neceessary to have accuracy, high speed of response, small thermal elements, and short range spans within the limits of —375 and +1000° F. Its output in psi. is proportional to the temperature of its thermal element. Using ¼-in. O.D. copper tubing, this pressure change can be transmitted as far as 1000 ft., or more depending on conditions. Among other features cited by the manufacturer are: 1) fixed air output range of 3 to 15 psi. for full temperature span is linear to 0.1%, assuring repeatability of readings, 2) compensation for barometric and ambient temperature changes, 3) interchangeable unit assemblies, and 4) thermal systems built to withstand overrange temperatures up to 1000° F. Instrument is fully encased, provided with mounting brackets for pipe or wall mounting, or an adjustable bracket when it is used with a separable bushing. Taylor Instrument Cos.



9—Four-leg Support



The Precision "Quod-Pod" Support features: 1) legs and bases which are interchangeable—two bases can be joined with common legs; and 2) legs which are movable through an arc of 270°—the four legs can be folded under the base. Bases and legs are joined by a single cap screw for each leg. Each base has seven and each leg has four threaded ½-in. holes to accommodate rod uprights. Vertical rods are made of steel, aluminum, or brass in 2, 3, 4, 5, and 6 ft. lengths. Support base is stamped from ¼-in steel plate. The ¾-in. square legs are made from aluminum bar. Precision Scientific Co.

More "What's New!" Items, p. 588

These are the tubes...

that stay on the job

CHASE

ANTIMONIAL ADMIRALTY

(a patented alloy)

Chase Antimonial Admiralty has been in use for 14 years, withstanding the test of time — *because* the percentage of antimony is *right*.

Admiralty containing less than .007% antimony (the minimum set forth in Chase Patent No. 2,061,921) cannot be counted on to prevent dezincification under all conditions. Over a wide range of applications, .015% is the minimum. Chase makes doubly sure you get this percentage—by using a nominal content of .035%, so that even with normal commercial variation your tubes contain at least .015% antimony.

That's why Chase patented Antimonial Admiralty tubes stay on the job, year after year. Get the facts!

Special stocks of
ANTIMONIAL ADMIRALTY
Condenser Tubes in Chase Warehouses:
BALTIMORE, NEW ORLEANS
LOS ANGELES, SAN FRANCISCO
also carried by—
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Standard Brass & Mfg. Co., Houston

Chase

the Nation's Headquarters for
BRASS & COPPER

WATERBURY 20 CONNECTICUT

SUBSIDIARY OF KENNECOTT COPPER CORPORATION

THIS IS THE CHASE NETWORK . . . *handiest way to buy brass*

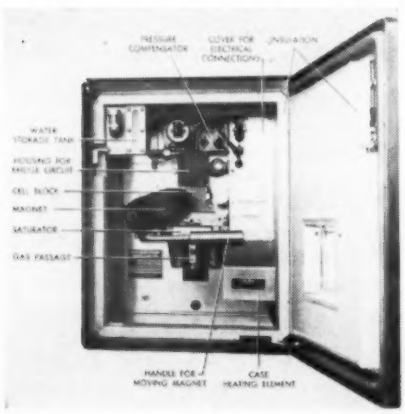
ALBANY† ATLANTA BALTIMORE BOSTON CHICAGO CINCINNATI CLEVELAND DALLAS DETROIT HOUSTON† INDIANAPOLIS KANSAS CITY, MO. LOS ANGELES MILWAUKEE MINNEAPOLIS NEWARK NEW ORLEANS NEW YORK PHILADELPHIA PITTSBURGH PROVIDENCE ROCHESTER† ST. LOUIS SAN FRANCISCO SEATTLE WATERBURY (†Sales Office Only)

10—Light-weight Motors

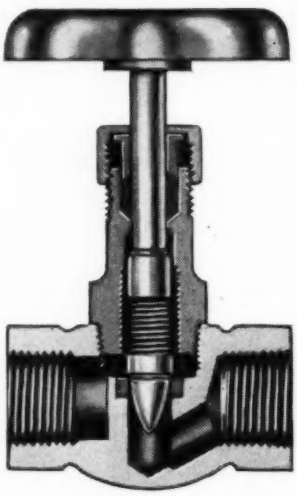
Suitable for use as drives for fans, blowers, and small pumps; the new line of Type KSP71, shaded pole, fractional hp., General Electric motors have a die-cast aluminum frame, with a resultant weight reduction over conventional types using cast-iron frames. The motors are available in these ratings: 1/40 hp., 50-60 cycle, totally enclosed; 1/25 hp., 60 cycle, totally enclosed; and 1/15 hp., 60 cycle, open. All ratings are available for 115 or 230 volts and for clock- or counterclockwise rotation. Models can be obtained for horizontal or vertical shaft operation in a variety of mountings, including shaft-end, opposite shaft-end, and resilient-base; or they can be band-mounted. General Electric Co.

11—Oxygen Meter

Following extensive field tests, the Hays "Magno-Therm" Oxygen Meter is now in full production, according to the manufacturer. The instrument employs no chemicals, liquids, gaseous fuels, or combustion in its operation. It is based on the principle of the paramagnetic property of oxygen. In operation, the amount of oxygen in a gas stream affects the resistance of an electrically-heated wire suspended in the stream and in the center of a strong permanent magnetic field. This resistance is compared to that of another hot wire not in the magnetic field but in the gas stream. Satisfactory installations have been made on catalyst regenerators, on boilers for determining combustion efficiency, and for safety tests on hazardous explosive gases. Hays Corp.



12—Throttling Valves



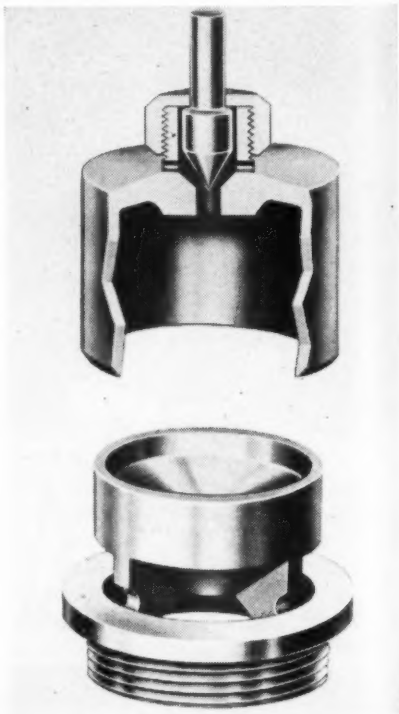
"Characterized" Needle Valves, No. 1050 and 1051, were designed to fill a need for corrosion resisting throttle valve in sizes ¼, ⅜, and ½ in. The seat is of Hastelloy "C". The needle point is proportioned to give graduated control from closed to wide open position. Teflon is employed for stem packing; in addition, No. 1051 has a Teflon shut-off disc. Valves are furnished in all types of corrosion resisting metals: maximum temperature is 550° F., maximum pressure, 2000 psig. Associated Valve & Engrg. Co.

13—Controller-air Generator

A new model of the standard Askania "Transometer" has been designed to generate air pressures that can be used directly with the present type of air supplied controllers. Previously, it was necessary to use a transformer between the Transometer and the controller. The unit will generate an air pressure signal from 2-15 psi. Combined with a positive displacement meter, it converts rpm. of the meter into an air pressure signal proportional to the square of the liquid flow. Viscosity effects on measurement are small compared with viscosity effects on measurements made by the usual orifice methods, it is said. Initial output pressure signal is adjustable over a range of 0-3 psi. and top output pressure signal over a range of 10-18 psi. The maximum input rpm. may vary from 25 to 3000 (or more). Askania Regulator Co.

14—Balanced Inner Valve

Being used exclusively in the Klipfel "500" series of regulating valves, a new cup disc and piston seat design inner valve is balanced when open and easily controlled by the diaphragm and unaffected by changes in inlet pressure. When closed it is held tight against the single seat by inlet pressure. As used in back pressure valves, the inlet pressure under the seat enters the cup and lifts it against the resistance of a spring, adjusted for a definite pressure. In other valves, the inlet pressure enters the cup through the port in the head, thereby balancing the cup as to pressure so that it is readily moved. After the cup seats, the balancing port closes and the valve is held in place by inlet pressure. The "500" series is designed for accurate control at inlet pressure below 250 psi. and reduced pressures below 150 psi. Sizes range from ¾ to 6 in. Klipfel Mfg. Co., Div. of Hamilton-Thomas Corp.



More "What's New!" Items, p. 591

You Get All 3

ACCURACY . . .
FLEXIBILITY . . .
RUGGEDNESS . . .

in the REPUBLIC *Pneumatic Transmitter*

When selecting a meter, whether it be for the measurement of flow, pressure, liquid level or liquid density, the experienced operator looks for these three important features.

He wants a meter that will give him accurate readings. He wants a meter that can be easily adapted to widely varying conditions. He wants a meter that is rugged enough to remain in service even under adverse operating conditions.

The Republic Pneumatic Transmitter has a guaranteed accuracy of within ½ of 1% of the transmitter range. This is higher than can be consistently secured and maintained with any other method. By making a few minor adjustments or substituting a few small parts its operation can be easily changed to any desired range between a minimum of 0—0.6" of water to a maximum of 0—704" of water. Its construction is more like that of a precision machine than of the sensitive instrument that it is.

It is for these reasons that the Republic Pneumatic Transmitter, even though comparatively new, has already been specified and installed on over 2500 industrial metering applications.

★ ★ ★

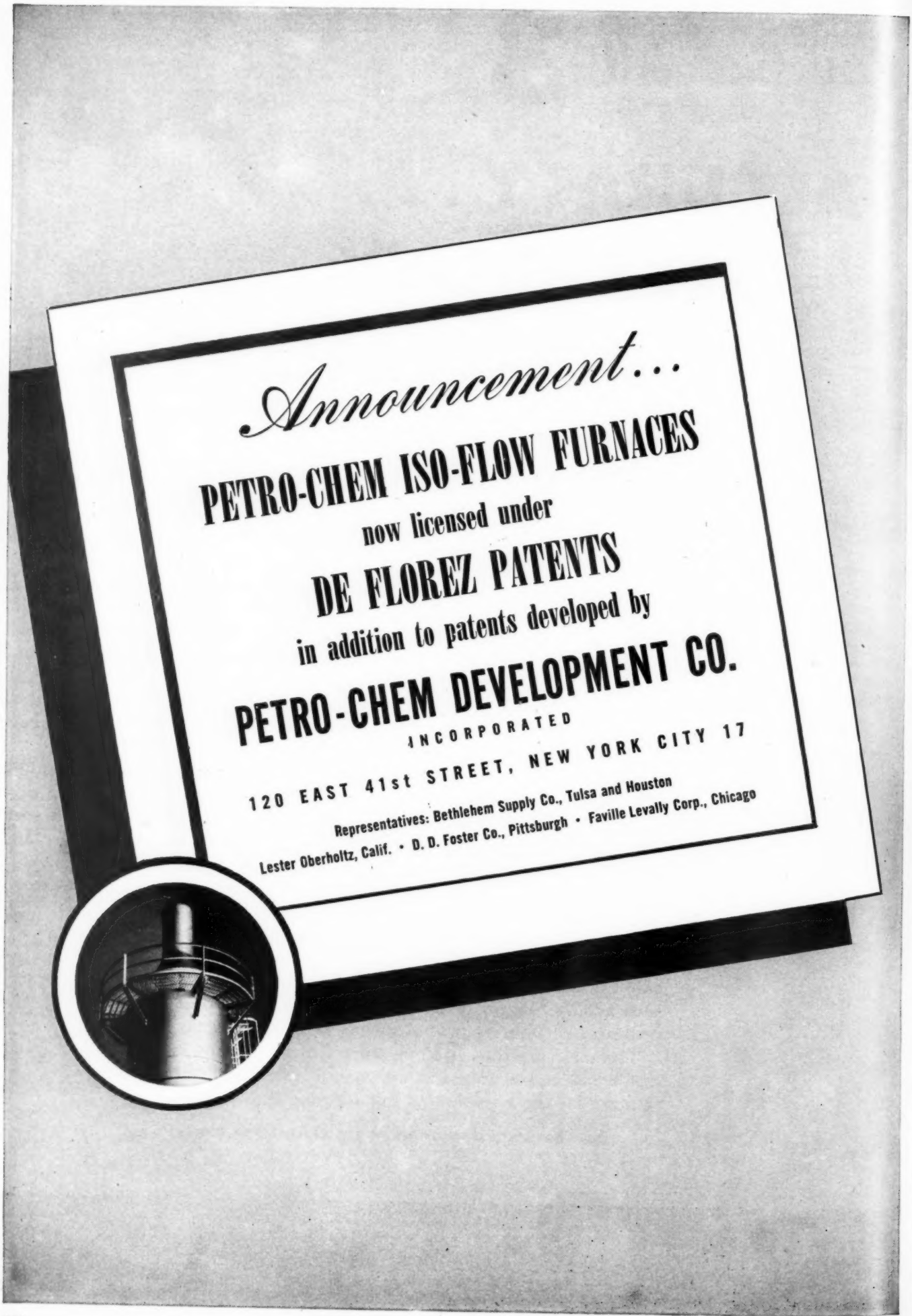
The Republic Transmitter is a pneumatic metering device. It employs the force-balance principle to convert process variables such as flow, liquid level, pressure or liquid density, into air pressures which vary proportionally with the process variables.

These air pressures become direct measurements and can be conducted to reading instruments or used as the measuring impulse for the actuation of an automatic controller.

For complete details write for Data Book No. 1001

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois


Announcement...
PETRO-CHEM ISO-FLOW FURNACES
now licensed under
DE FLOREZ PATENTS
in addition to patents developed by
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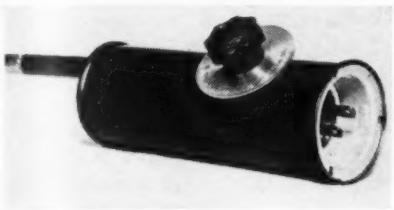
INCORPORATED
120 EAST 41st STREET, NEW YORK CITY 17
Representatives: Bethlehem Supply Co., Tulsa and Houston
Lester Oberholtz, Calif. • D. D. Foster Co., Pittsburgh • Faville Levally Corp., Chicago

15—Electronic Vacuum Control



The "SMCI" vacuum control accessory is based upon a principle of adjustable pulsed leak, and is continuously adjustable from completely closed to open. Manufacturer states it cannot plug up with dust or moisture and may be used with any gas. It can be used alone to give the desired vacuum by balancing the leak rate against the pump rate, or it may be employed with the SMCI Skanascope Vacuum Relay Monitor to maintain the desired vacuum regardless of varying conditions within the vacuum system. Unit measures 6½ in. x 2 in. O.D., with a 4-in. exhaust tube, and includes 5 ft. of cable. It weighs 1 lb., and operates on 110 volt, A.C. Skaneateles Mfg. Co., Inc.

16—Heavy-duty Wrench

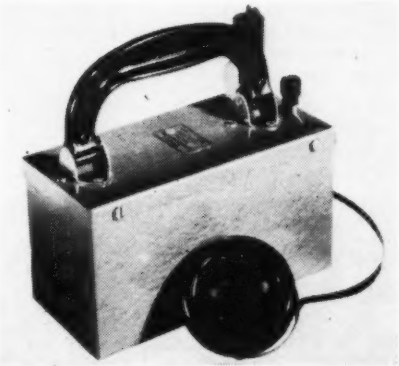
The Ingersoll-Rand, Size 577, Impact Wrench is a heavy-duty tool designed to handle large studs, bolts, nuts, cap screws, from 1¼ to 2 in. thread size. Air-actuated, it operates on the rotary impact principle, by which motor torque is converted into 1000 "twisting" blows per minute. It has been found especially useful for removing rusted or frozen nuts. Specifications are as follows: weight, less socket—72 lbs.; overall length to shoulder of square driver—24½ in.; side to center distance of hammer case—2 13/16 in.; rated capacity—2-in.; size of square driver, across flats—1½ in.; free speed—535 to 565 rpm. Ingersoll-Rand Co.

17—Small-scale Pulverizer

Essentially a small, high-speed hammer mill, with non-pivoting hammers, the "Precision-Shell" Sample Pulverizer has been developed for grinding small samples from 3 to 30 grams. It will reduce 4 or 8 mesh material to 50 mesh or finer, and has been used successfully to grind materials of a wide range of hardness—activated alumina, rock salt, marble chips, quartz, and the like. A 5-gm. sample can be ground in from 1 to 4 minutes, depending upon the hardness. Precision Scientific Co.

18—Geiger Counter

A new portable Geiger counter, sensitive to both gamma rays and beta particles, is suitable for auditory monitoring in the laboratory and in the field. It can be carried on the belt or by its handle. It employs a 900-volt, plug-in type Geiger tube with a 30 mg./cm.^{2} thin window section, making possible the detection of beta particles as low as 160 KEV, as well as gamma rays. The unit weighs about 2 lbs., including battery. Size is 2¾ x 3¼ x 6 in. Precision Radiation Instruments, Inc.



More "What's New!" Items, p. 592

AMMONIA
(Refrigeration Grade)

TANK CARS and CYLINDERS

direct service from producing point to user available on contract shipments or spot orders from...

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SPENCER CHEMICAL COMPANY
Executive and Sales Offices
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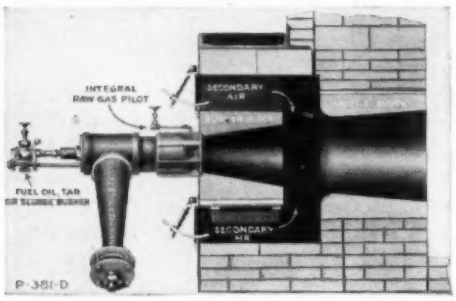
CONTACT SPENCER NOW FOR YOUR AMMONIA NEEDS

NATIONAL AIROIL FUEL OIL · GAS BURNERS

OIL-GAS TANDEM COMBUSTION UNIT...



HAS A HIGH TURN-DOWN RATIO WITH A STEADY FLAME

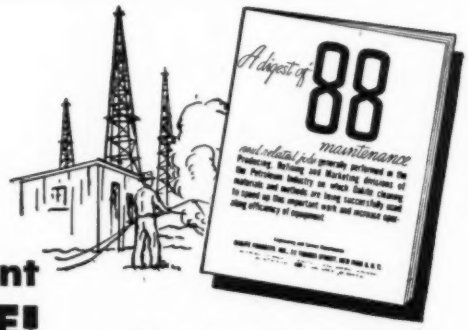
OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

Advantages: Requires only a minimum of furnace draft with low excess combustion air; Burns all grades of oil fuels, sludges and refuse oils; Attains smokeless combustion even on low settings. Another model of this Unit is designed for firing vertically upward . . . Also, suitable for forced draft preheated air. It can be applied to all types of boilers and process furnaces. Full details in Supplement 6 to Bulletin 50.

NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: 1297 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.
Texas Office: 2512 South Boulevard, Houston 6

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT



your guide to steam-detergent cleaning—FREE!

If you are in the producing, refining, natural gas or pipe line divisions, the guide above, is for you. It contains facts designed to help you save on your cleaning jobs.

Guide gives full details about built-for-the-job Oakite Solution-Discharging Steam Gun and the low-cost, easy way to install it. Tells how to make up steam-cleaning solution with effective Oakite cleaning compounds. Also gives full details for stripping paint with the Oakite Gun. Shows how you can simplify such jobs as cleaning pump and drilling equipment; rotary tables, mud hogs, crown blocks, swivels and the like. It's not only versatile, but being 3-ways effective (steam, pressure, detergency) it lops hours off your maintenance-cleaning schedule. Why not arrange with your neighborhood Oakite Technical Service Representative for a demonstration. Or . . .

JUST SAY THE WORD AND we'll send you this "Oakite 88 Digest." Our address: Oakite Products, Inc., 44C Thames St., New York 6, N.Y.

OAKITE 1909 1949 40th ANNIVERSARY YEAR

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE

REG. U.S. PAT. OFF.

SPECIALIZED INDUSTRIAL CLEANING

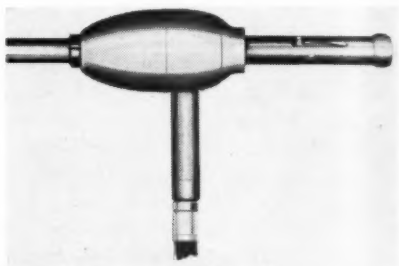
MATERIALS • METHODS • SERVICE

OAKITE PRODUCTS, INC., 50E Thames St., NEW YORK 6, N. Y.

What's New!

19—Condenser Tube Cutter

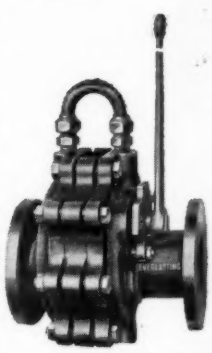
A new condenser tube cutter, internal type, will be made available to the trade soon, according to the manufacturer. It is designed for tubes ranging in size from ½ to 1½ in. in diameter. Made of heat-treated alloy steel throughout, with a blade of tool steel, the cutter is equipped with an airline for blowing out cuttings, to prevent jamming, and to keep the bit cool. Designed for air or electric motor drive, the cutter may be operated at speeds of 250 to 750 rpm. It will cut through tube sheet thicknesses from ½ to 6 in. Airetool Mfg. Co.



20—Wax and Oil Solvent

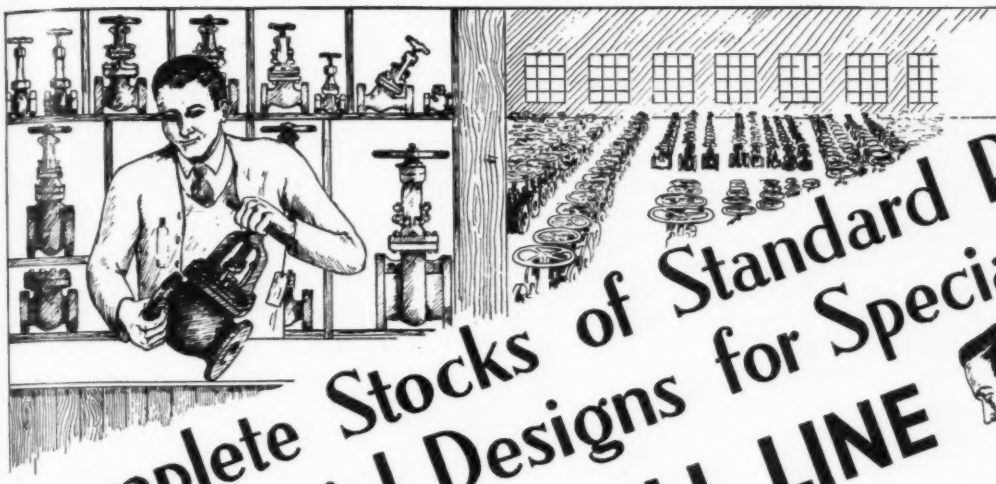
"Visco VS" is a new high-flash-point solvent for wax, grease, lube oils, paint, and fusible or soft resins which manufacturer states is safer to use than naphtha or other low-flash-point materials. It is non-injurious to the skin. Visco VS is available immediately in 55-gal. drums and 5-gal. cans, direct from factory at Sugarland, Texas. Visco Products Co., Inc.

21—Steam-jacketed Valve



The "Everlasting" Steam Jacketed Valve has been developed for the transmission of viscous materials which congeal and do not flow at ordinary temperatures. The valves are of the quick-acting type where the disc slides across the ports in a rotating, self-cleaning action. Jacket space surrounds the port openings as well as the valve body. Valves are available in 2, 3, and 4-in. sizes, for 125 psi. line and 125 psi. jacket pressure. Everlasting Valve Co.

More "What's New!" Items, p. 594



Complete Stocks of Standard Patterns + Special Designs for Special Services = the POWELL LINE

Powell presents a Complete Line of Standard Valves—in Bronze, Iron, Steel, Pure Metals and Special Alloys.* These are of every type and size, and for all pressures and temperatures encountered in the many services for which they are adapted.

But ever-changing methods and processes continually impose new flow control conditions. For these Special Services, Powell Engineers are always ready with Special Designs.

The result is that Powell—and only Powell—makes such a complete line that today there's a Powell Valve specifically adapted to each and every flow control service known to Industry.

Write for information on applications of Powell Valves. And if you have any flow control problems, Powell Engineers will help you solve them.

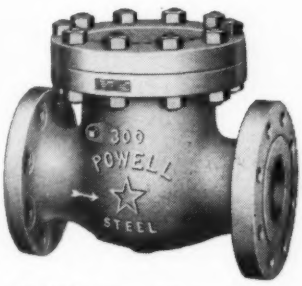


Fig. 3061—Class 300-pound Cast Steel Swing Check Valve with bolted cap and flanged ends. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

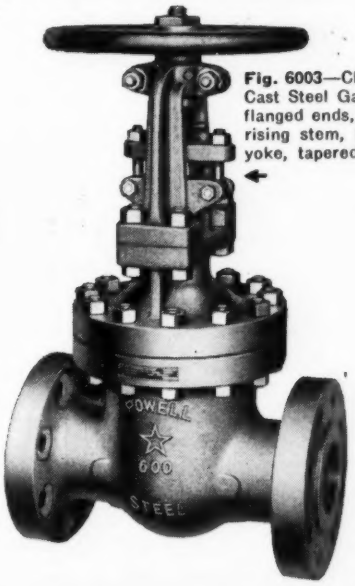


Fig. 6003—Class 600-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, tapered solid wedge.

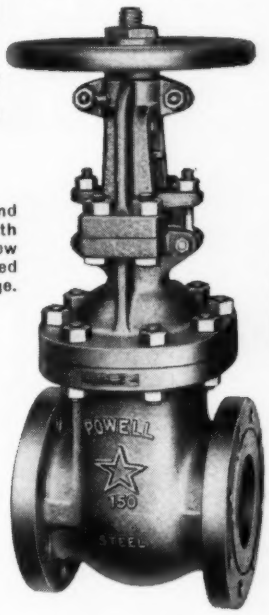


Fig. 1503—Class 150-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge.

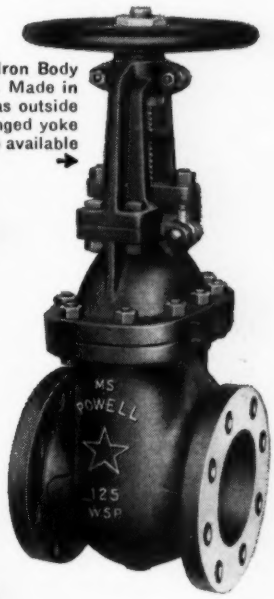


Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and tapered solid wedge. Also available in All Iron for process lines.

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

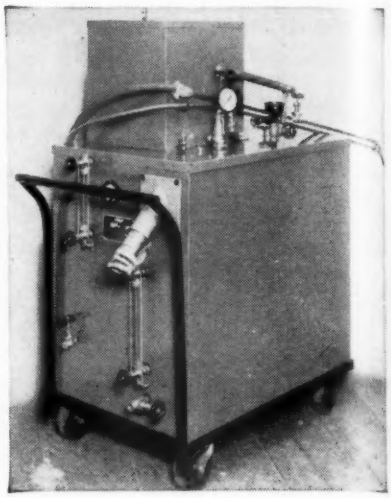
POWELL VALVES

22—New Chemical

The properties of sodium trifluoroacetate suggest the possibility of its application in preparing insecticides, herbicides, and dyestuffs. The compound is in the form of a white, odorless, non-corrosive, free-flowing powder. It is non-toxic, and 98 to 99% pure. A hygroscopic material, when converted to the acid as generally done for chemical processing, the acid is highly ionized. Hooker Electrochemical Co.

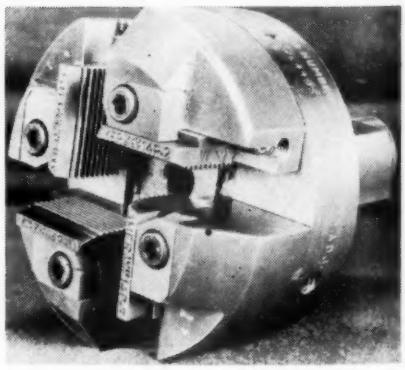
23—Steam-jet Floor Cleaner

The "Speedylectric" JC-30 Steam-Jet Cleaner, using high pressure steam from its built-in boiler, is said to eliminate the excess water problems common to the conventional type of cleaners which normally use hot water under pressure and tend to flood the floor area being cleaned. A mixing device mixes the steam with the proper amount of detergent at the jet. High velocity of the jet assures the operator of reaching high,



out-of-the-way places. Sparks and flames are eliminated, making the unit safe for use in hazardous locations. Mounted on an all steel dolly with ball-bearing, rubber-tired swivel casters, the JC-30 weighs about 500 lbs. Floor space occupied measures 27 x 40 in. Unit operates on 220 volts, A.C., single or polyphase. Livingstone Engrg. Co.

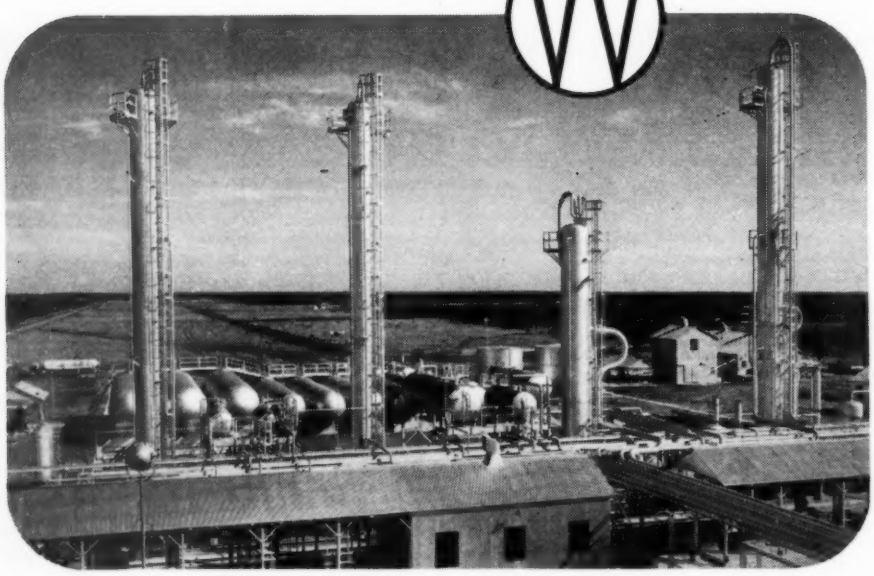
24—Thread Die for Ells



A new die head, recommended for use only on cast iron and brass fittings, is designed for threading street ells and similar fittings where clearances are limited between the die head and the machine proper. The diameter of the die head is 3¾ in. and to provide further clearance, the chaser holders are beveled off on a 45° angle. Individual adjustment is provided for each chaser holder, permitting a plus or minus adjustment of approximately 1/32 in. on the pitch diameter. Landis Machine Co.

More "What's New!" Items, p. 596

For STABILIZATION



WARREN PETROLEUM CORPORATION

Western Heat Transfer Equipment plays an important role in the manufacture of stabilized natural gasoline at Warren Petroleum's Holliday, Texas plant, pictured above. Close attention to detail and specification from design to installation is the prime consideration in the manufacture of all Western equipment for gasoline plants, refineries, chemical processing plants and pipe lines throughout the world.

WESTERN
HEAT EXCHANGERS
Manufactured by
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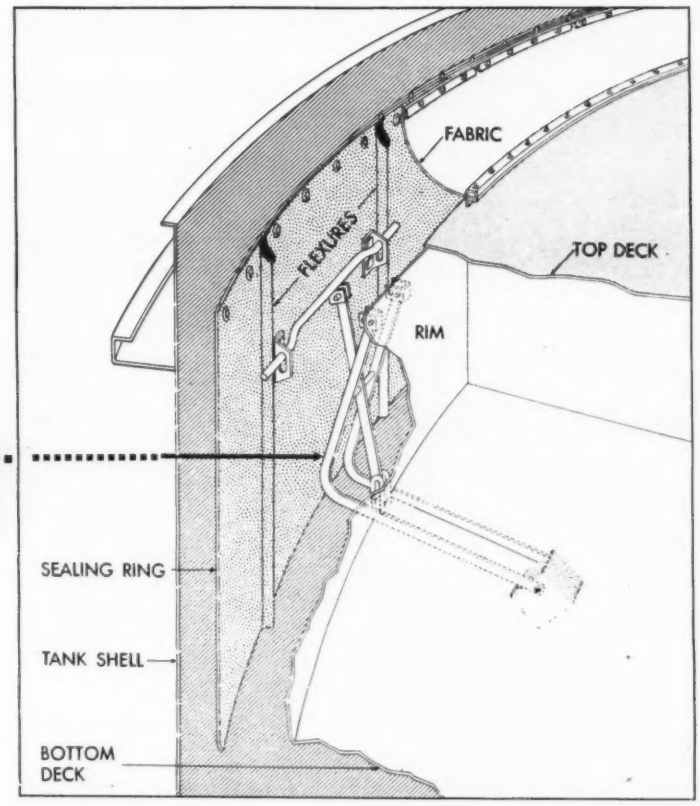
SALES OFFICES — DALLAS — HOUSTON

See Western's catalog pages in the current issues of Chemical Engineering Catalog, Refinery Catalog and Thomas Register.

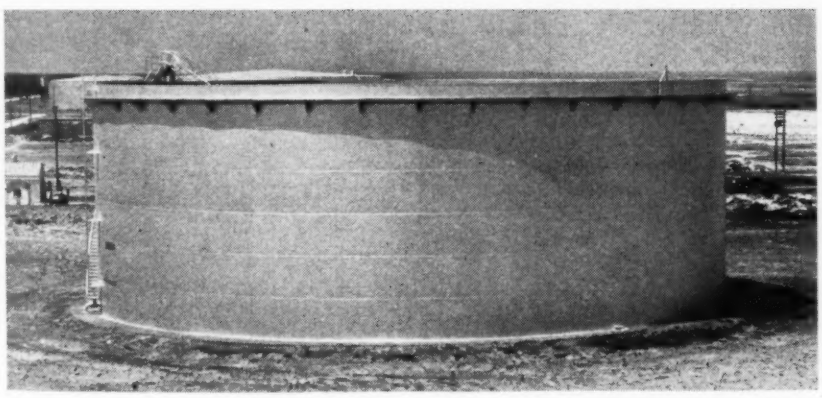
Making a good seal better

The New PANTAGRAPH HANGER

. . . now standard construction on



HORTON Double-Deck Floating Roofs



Above: Cutaway drawing showing the improved pantagraph hangers which hold the sealing rings on Horton Floating roofs snugly against the tank shells. Located inside the seal, the hangers are protected from the weather, and the roof deck is left free of obstructions for easy maintenance. Left: A 131,500-bbl. tank with a Horton Floating Roof at the Sun Pipe Line Company's Harbor City, Texas, terminal.

On the Horton Double-Deck Floating Roof, the new pantagraph hangers are part of the Horton Seal—the most efficient device ever developed to close the space between the deck of a floating roof and the tank shell. The job of the hangers is to hold a flexible metal sealing ring snugly against the shell of the tank, and to do this so that the sealing ring maintains a long sliding contact with the shell as the roof moves up and down.

With new engineering developments of this kind, the Horton Double-Deck Floating Roof offers you more economical protection against evaporation loss and dependable, maintenance-free operation. You can use the Horton Floating Roof on new or existing tanks. In the Horton line, flat-bottom oil storage tanks are built in standard sizes from 1,000 to 150,000-bbl. capacities. Ask our nearest office for complete information.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

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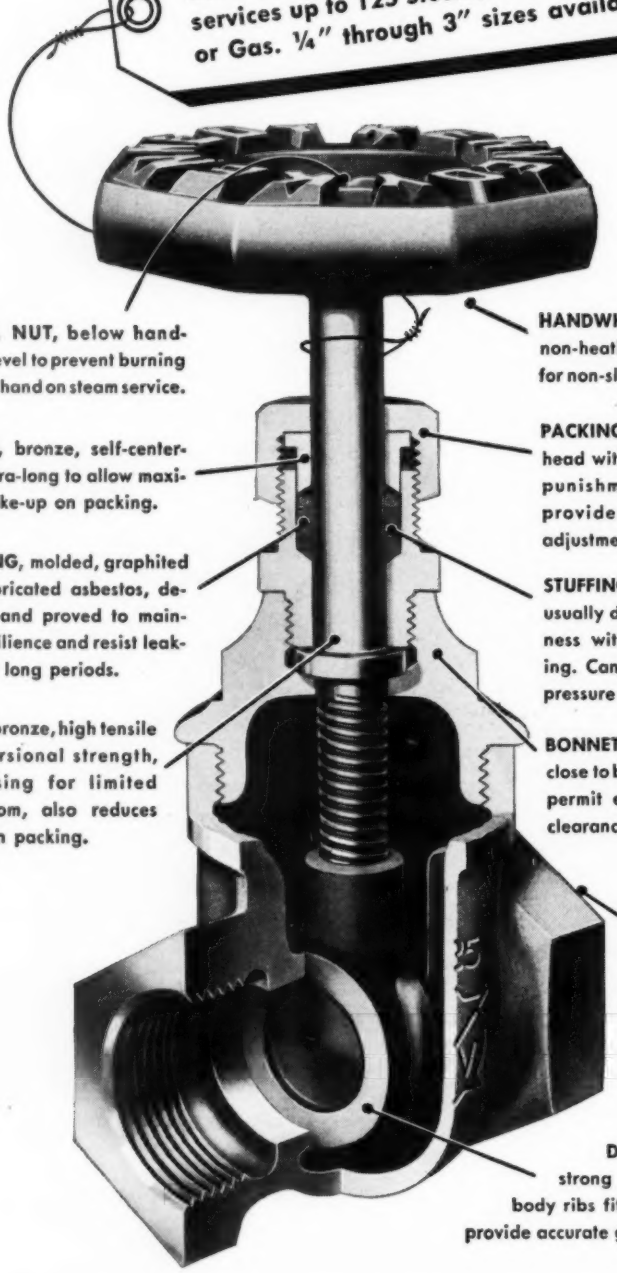
Birmingham 1 . . . . . 1527 North Fiftieth Street
Boston 10 . . . . . 1029-201 Devonshire Street
Chicago 4 . . . . . 2114 McCormick Building
Cleveland 15 . . . . . 2215 Guildhall Building
Detroit 26 . . . . . 1532 Lafayette Building
Houston 2 . . . . 2130 National Standard Building
Havana . . . . . 402 Abreu Building
Los Angeles 14 1526 General Petroleum Building
New York 6 . . . . 3310-165 Broadway Building
Philadelphia 3 . . 1630—1700 Walnut St. Building
Salt Lake City 1 1530 First Security Bk. Building
San Francisco 11 . . 1208—22 Battery St. Building
Seattle 1 . . . . . 1330 Henry Building
Tulsa 3 . . . . . 1620 Hunt Building

REPRESENTATIVES AND LICENSEES

Horton Steel Works, Limited, Fort Erie, Ontario, Canada
Ateliers et Chantiers de la Seine Maritime, Paris, France
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Compania Tecnica Industrie Petroli, S.A. 1, Rome, Italy
Whessoe, Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Chicago Bridge & Iron Company, Limited, Apartado 1348, Caracas, Venezuela

Design and Engineering Put EXTRA Value In This KENNEDY VALVE

KENNEDY STANDARD BRONZE GATE VALVE, FIG. 27, non-rising stem. Conservatively rated for services up to 125 Steam, 175 Water, Oil or Gas. ¼" through 3" sizes available.



WHEEL NUT, below handwheel level to prevent burning palm of hand on steam service.

GLAND, bronze, self-centering, extra-long to allow maximum take-up on packing.

PACKING, molded, graphited and lubricated asbestos, designed and proved to maintain resilience and resist leakage for long periods.

STEM, bronze, high tensile and torsional strength, non-rising for limited headroom, also reduces wear on packing.

HANDWHEEL, malleable iron, non-heating design, large size for non-slip, comfortable grip.

PACKING NUT, bronze, heavy head withstands pipe wrench punishment, extra threads provide increased packing adjustment.

STUFFING BOX, bronze, unusually deep to provide tightness without jamming packing. Can be repacked under pressure wide open.

BONNET, bronze, large hexes close to body increase rigidity, permit easier removal when clearances are close.

BODY, bronze, rugged construction, straight passageway minimizes flow resistance, disc clears passageway in full open position.

DISC, bronze, simple, strong mechanism. Interior body ribs fit channels on disc to provide accurate guide.

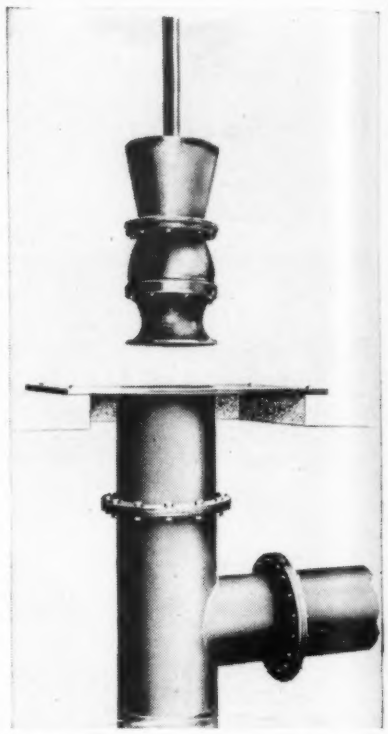
Write for Bulletin No. 102 • **BUY FROM YOUR LOCAL DISTRIBUTOR**

THE **KENNEDY** VALVE MFG. CO.
1067 EAST WATER ST.
ELMIRA, NEW YORK
VALVES • PIPE FITTINGS • FIRE HYDRANTS

OFFICE-WAREHOUSES IN NEW YORK, CHICAGO, SAN FRANCISCO • SALES REPRESENTATIVES IN PRINCIPAL CITIES

What's New!

25—Pump Inspection Easy



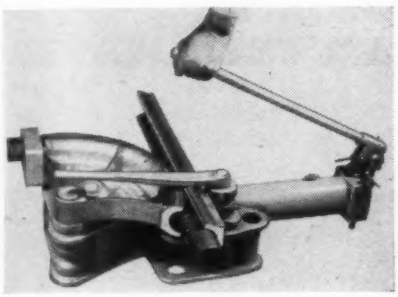
"Pull-Out" models of axial flow and mixed flow type pumps, available in capacities up to 100,000 gpm., have been designed so that all working parts are removable without breaking discharge connections. Suction bell, impeller, impeller housing, shaft, motor base, and motor can be removed without disturbing the column and discharge elbow. The units are especially recommended for power plant condenser circulation and other continuous operation where periodic inspections are desired without breaking pipe or mounting connections. They are said to be advantageous when the discharge elbow is below floor level, or when the pit is not easily drained. Pumps are supplied in cast or welded construction, and of alloy materials if specified. Economy Pumps, Inc.

26—Cutter for Hard Metals

Through compound leverage, the "Manco" Special Center-Cut Bolt Cutter affords two tons cutting power at the jaws with 50 lbs. pressure on the handles. Jaws are of forged tool steel, heat-treated for handling case-hardened bolts, chain, reinforcing rods, and the like. The cutter is available in 18, 24, 30, and 36 in. sizes with capacities up to $\frac{7}{16}$-in. solid rod. The cutter assembly will fit standard bolt cutters now in the field and may be obtained separately through regular mill supply channels. Manco Mfg. Co.

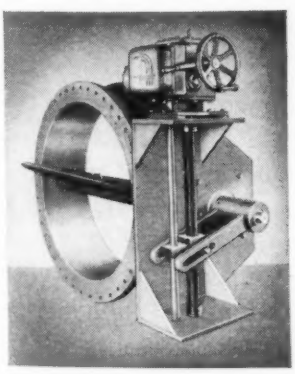
27—Portable Pipe Bender

A new portable, hydraulic bending machine, now in commercial production, is said to be able to handle regular and extra heavy pipe and rigid conduit in sizes from ⅜ to 4 in. The manufacturer states 90° bends can be made in 4-in. pipe in 15 minutes. The unit is practical for hard copper, stainless steel, and other metals. Changeovers from one size to another can be accomplished in a matter of seconds. Machine is mounted on casters. Attachment for motorizing also can be furnished. Tal Bender, Inc.



28—Hydraulic Service Valve

A 54-in. 50-lb., iron valve has been developed for hydraulic service and especially for controlling flow of condenser water. The valve has 125 psi. American Standard flanges and is operated by a limitorque electric motor connected to a threaded reach rod that moves the valve slowly to prevent water hammer. Reach rod threads can be cut for a range of speeds from 60 secs. up to 8 min. The valve is available in larger sizes, for higher pressures, and in materials other than iron. R-S Products Corp.



Trade Literature

29—Marshall Plan Sales

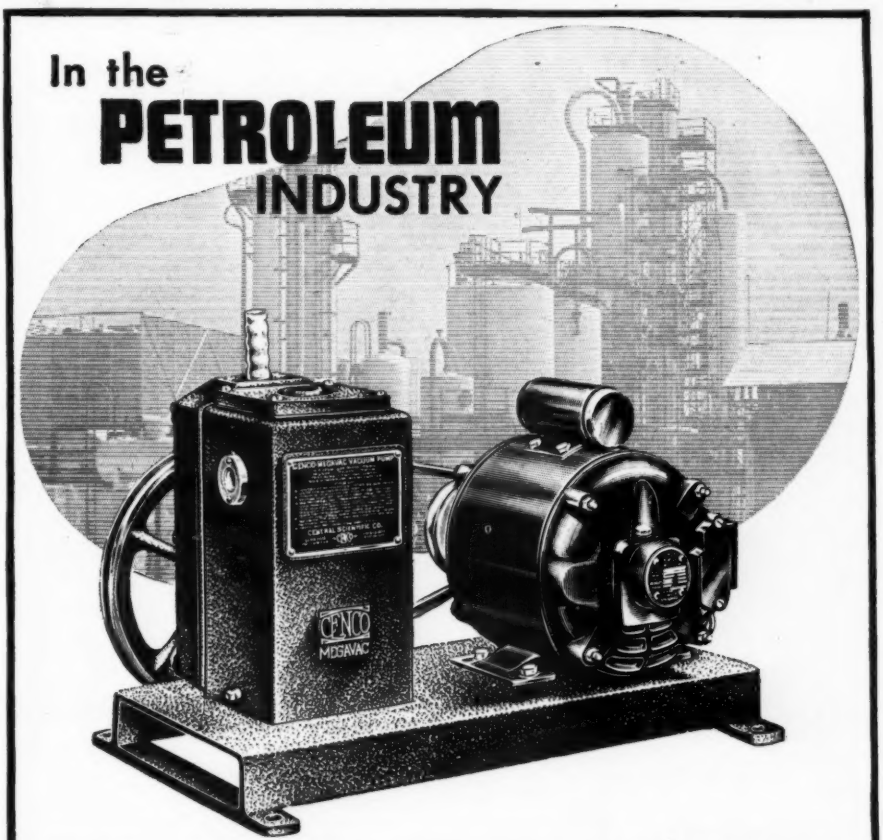
The Marshall Plan Sales Planner: a six-color, 30 x 40-in. chart illustrating how American companies can benefit by Marshall Plan sales to participating countries; depicting graphically the kinds of products that will be purchased during 1949-50, the approximate dollar volume, and the percentage distribution both as to source and to destination. Of particular help is a 12-step procedure recommended for American suppliers. Anticipated dollar volume for petroleum and its products is indicated at about $150 million. Westinghouse Electric Corp.

30—Corrosion-resistant Paint

Prufcoat Proof Packet: a standard-size, filing folder containing reports from testing laboratories, case histories, the Prufcoat Protectograph Plan for analyzing paint maintenance costs, price list, and general catalog information on a line of corrosion resisting coatings for acids, alkalis, oil, and water. Prufcoat Laboratories, Inc.

More "What's New!" Items, p. 599

In the **PETROLEUM INDUSTRY**



THE CENCO-MEGAVAC PUMP

combines in a single mechanical unit high ultimate vacuum with high pumping speeds for fractional distillations, temperature and pressure measurements and other laboratory or pilot plant procedure which requires fast initial evacuation. This unit is proved for dependable and trouble-free service. Speed at 1 micron, 375 ml; vacuum, 0.1 micron or better.

Specify No. 92015A Cenco-Megavac Pump mounted with base and motor for 115 volt, 60 cycle AC operation . $198.00

(Also available with motors for other voltages and frequencies.)

SERVING SCIENCE CENCO

Write Dept. B. E. for engineering Bulletin 10 "High Vacuum Equipment".

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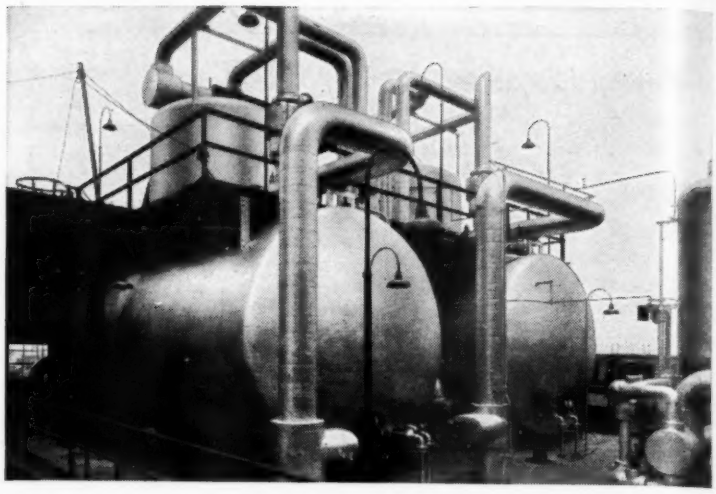
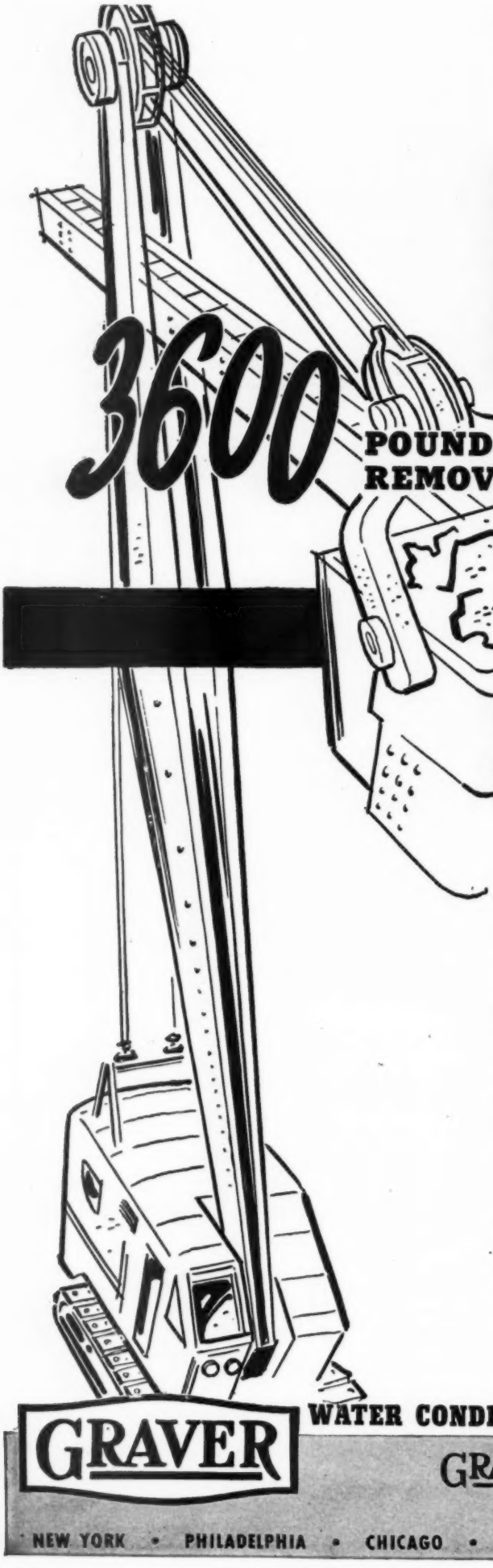
NEW YORK BOSTON SAN FRANCISCO NEWARK LOS ANGELES TORONTO MONTREAL



3600 POUNDS OF SCALE PER DAY REMOVED FROM BOILER FEED WATER



by GRAVER Hot Process Water Treating System

This is what a Graver two stage Hot Process water treating plant is doing at a large oil refinery. A million pounds of lake water per hour, taken from a canal, is treated as makeup for a battery of high pressure boilers. A million pounds of this untreated water contains approximately 150 pounds of scale forming material. This means about 3600 pounds every 24-hour day. Heaters, sedimentation tanks, filters, and deaerating equipment give the boiler system complete protection against scale and corrosion.

If your problem involves treatment of water for boiler feed, process, or industrial waste water treatment of small or large capacities . . . you will find Graver water conditioning equipment does the job efficiently and economically. *All* types are available, for all jobs, in all capacities. Write today for recommendations and a survey of your water conditioning problem.

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WATER CONDITIONING & PROCESS EQUIPMENT DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

31—Chemicals

Celanese Chemicals; 24-page booklet containing specifications, shipping and storage instructions, corrosion data, uses, typical reactions, and toxic properties on nine chemical compounds now in volume production; including formaldehyde, acetone, methanol, glacial acetic acid, n-propanol, acetaldehyde, tricresyl phosphate, methyal, and propionaldehyde. Celanese Corp of America.

32—Liquid Level Transmitter

Taylor Force-Balance Liquid Level Transmitter, Bulletin 98069: gives data on an instrument designed specifically to measure pressure and liquid level of viscous or corrosive liquids, and liquids containing solids, and adaptable to open or closed tanks under pressure or vacuum. Taylor instrument Cos.

33—Flowmeter Manufacture

Making Hays-Cochrane Flow Meters at Penn Industrial Instrument Corp. Plant in Philadelphia, Bulletin No. 800: 8 pages of photographs showing steps in making a line of electric and mechanical flow meters, now being marketed as "Hays-Penn" Meters through the Hays Corp., and being manufactured by Penn Industrial Instrument Corp.

34—Liquid Entrainment

Little Known Ways to Save Big Money with Fine Wire, Bulletin, 11: 8 pages describing a fine wire mesh, available in most metals and alloys, useful as separator elements in pipe still towers, gas absorbers, scrubbers. dehydrators, knock out drums, evaporators, gas separators, etc. Otto H. York, Inc.

35—Water Treatment

Wright Chemicals for Conditioning Aqueous Systems: 8-page bulletin covering a series of organic-inorganic compounds for water treatment, including four products for scale control, two corrosion inhibitors, three chemicals for algae control, and several special purpose formulas. Wright Chemical Corp.

36—Corrosion Guide

Solving Corrosion Problems with Chemalloy High-Alloy Castings: a six page folder featuring two charts for alloy selection, one showing the comparative resistance of the most commonly used grades of alloys in 179 different corrosive media, and the other listing the alloys with their nominal composition, mechanical properties, etc. American Brake Shoe Co., Electro-Alloys Division.

37—Corrosion-resistant Piping

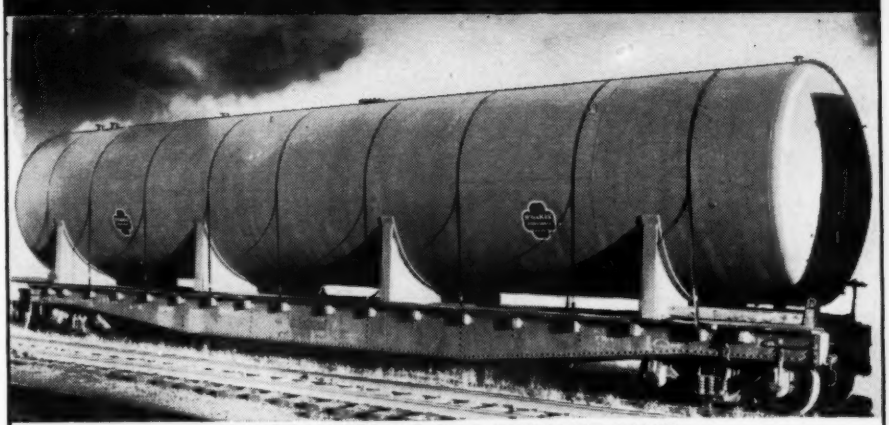
Corrosion-Resistant Piping Materials, Circular No. 320: 32-page booklet giving complete information on entire line of valves, fittings, fabricated piping, and pipe coils for corrosive conditions; includes eight pages of condensed recommendations, description of alloys, and a corrosion questionnaire. Crane Co.

38—Chemicals Catalog

General Products List, 1949-1950, Bulletin 100: 20 pages on Hooker's chemical products — specifications, uses, shipping information—and specialized processes by which the compounds are made—chlorination, hydrogenation, phosgenation, sulfhydration, metallic chlorination, hydrochlorination, and fluorination. Hooker Electrochemical Co.

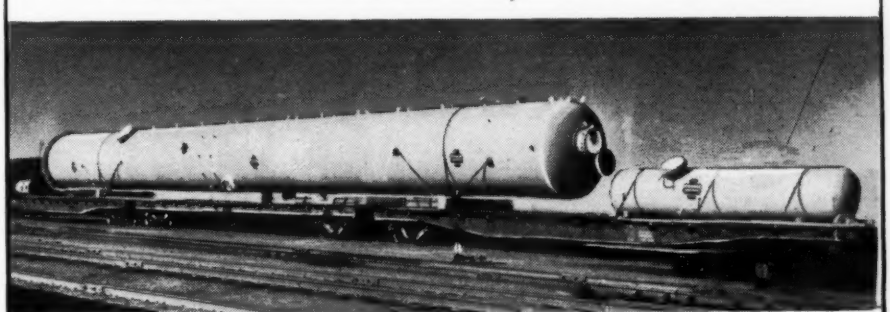
More "What's New!" Items, p. 600

STORAGE VESSELS now a * production line item at McNamar



45,000 GALLON LP-GAS STORAGE TANK

McNAMAR HAS INCREASED PLANT SPACE BY 30,000 SQ. FEET FOR THE EXCLUSIVE FABRICATION OF STORAGE VESSELS!



MAIN FRACTIONATING COLUMN ON 3 CARS ENROUTE TO CUSTOMER

★ REFINERY TOWERS
★ STORAGE TANKS
★ HEAT EXCHANGERS
★ ACCUMULATORS
★ STRUCTURAL SHAPES
★ MISC. REFINERY VESSELS

● GLAD TO FURNISH QUOTATIONS PROMPTLY ●

McNAMAR BOILER & TANK CO.

REFINERY SALES DIV.
BOX 868
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ROTARY
R-C Blower and Gas Booster mounted on same bedplate, with V-belt drives from 5 HP motor. Capacity, 125 CFM.
ONLY R-C dual-ability GIVES YOU dual choice
CENTRIFUGAL
R-C Centrifugal Blower —24" type OIB, driven by 250 HP motor. Capacity, 15,220 CFM.
H-173A

When it comes to choosing between Centrifugal and Rotary Positive Blowers and Exhausters, you'll get impartial suggestions from R-C *dual-ability*. That's because we build both —and we are the only blower manufacturer who gives you the benefit of this *dual choice.*

Another advantage of consulting us results from our wide range of units of both types. If it's 10 CFM you need, we'll supply it. Or, if your use calls for extremely large volume, we build them to any desired size.

One more point—air or gas handling equipment is our "bread and butter" . . . we have no other business. That means detailed and *interested* attention to your requirements from an organization that has specialized on that job for almost a century.

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BLOWERS • EXHAUSTERS • BOOSTERS • LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

★ ★ ONE OF THE DRESSER INDUSTRIES ★ ★

What's New!

39—Waste Treatment

For Effective Neutralization of Industrial Wastes—Micromax Automatic pH Control, Bulletin ND-44-96-708: 20 pages describing two systems, one electric and the other pneumatic, of pH equipment for combatting stream pollution through neutralizing waste from oil refineries, chemical works, and other industries. Leeds & Northrup Co.

40—Continuous Drainers

Industrol Continuous Drainers, Bulletin CD-100: a one-page leaflet on equipment for removing large quantities of condensate from preheaters, reboilers, and the like; standard sizes ranging from 4500 to 82,000 lbs./hr. of condensate at pressures to 600 psig. The Industrol Corp.

41—Cooling Towers

The New Aquatower, Bulletin AQ-49: covers specifications, engineering data, and application information on a line of cooling towers including a new model in the 7½ ton size. The Marley Co., Inc.

42—Steam Specialties

Strong Steam Specialties, Catalog No. 68A: 32-page booklet on traps, strainers, reducing valves, and separators, with prices on all items; includes quick-reference data table, and tips on selection, sizing, and maintenance of steam traps. Strong, Carlisle & Hammond Co.

43—Air-cooled Exchangers

G-R News, March 1949, issue: describes applications for "Fin-Fan" air-cooled heat exchangers in a number of different type installations. Griscom-Russell Co.

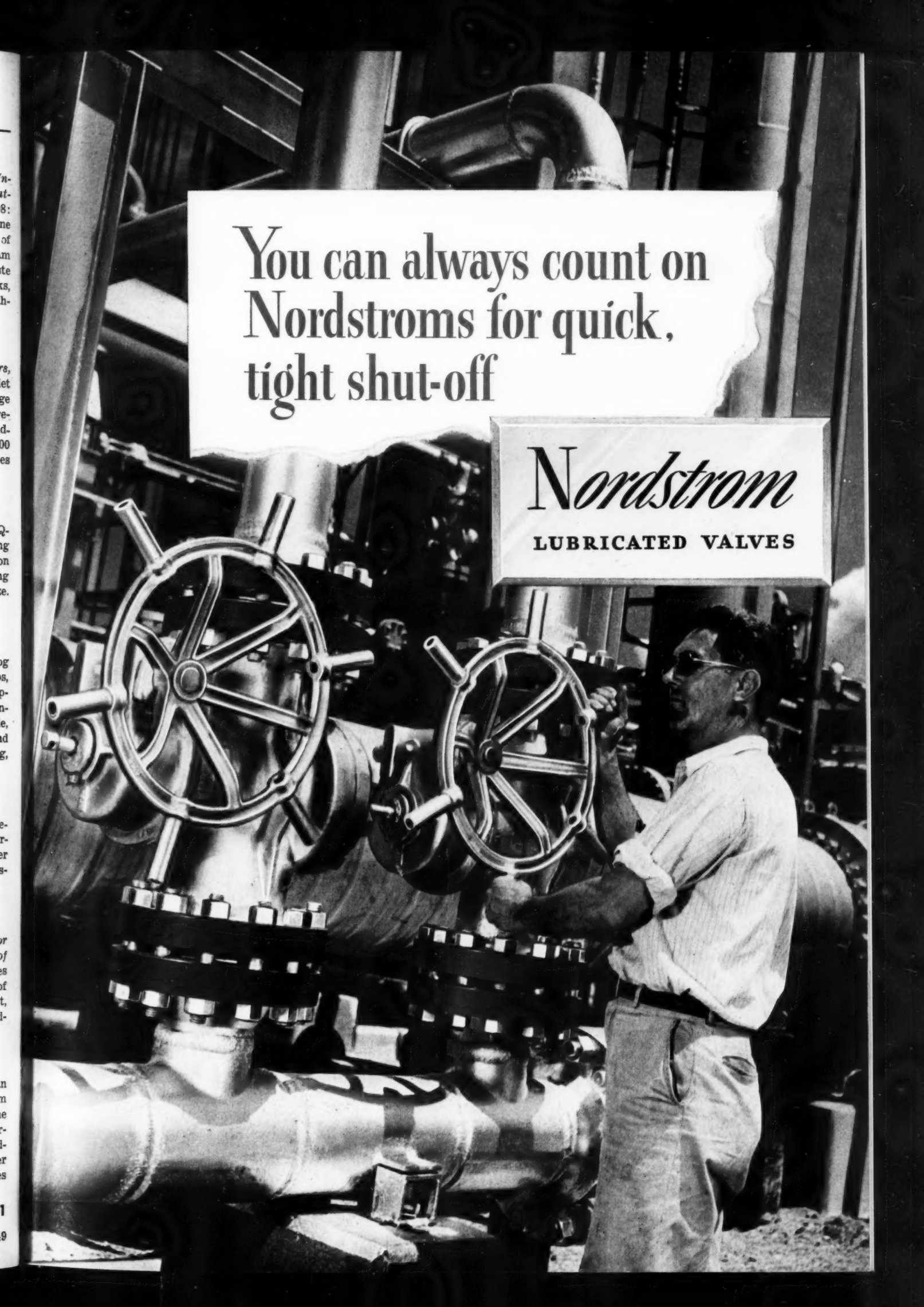
44—Thickness Gage

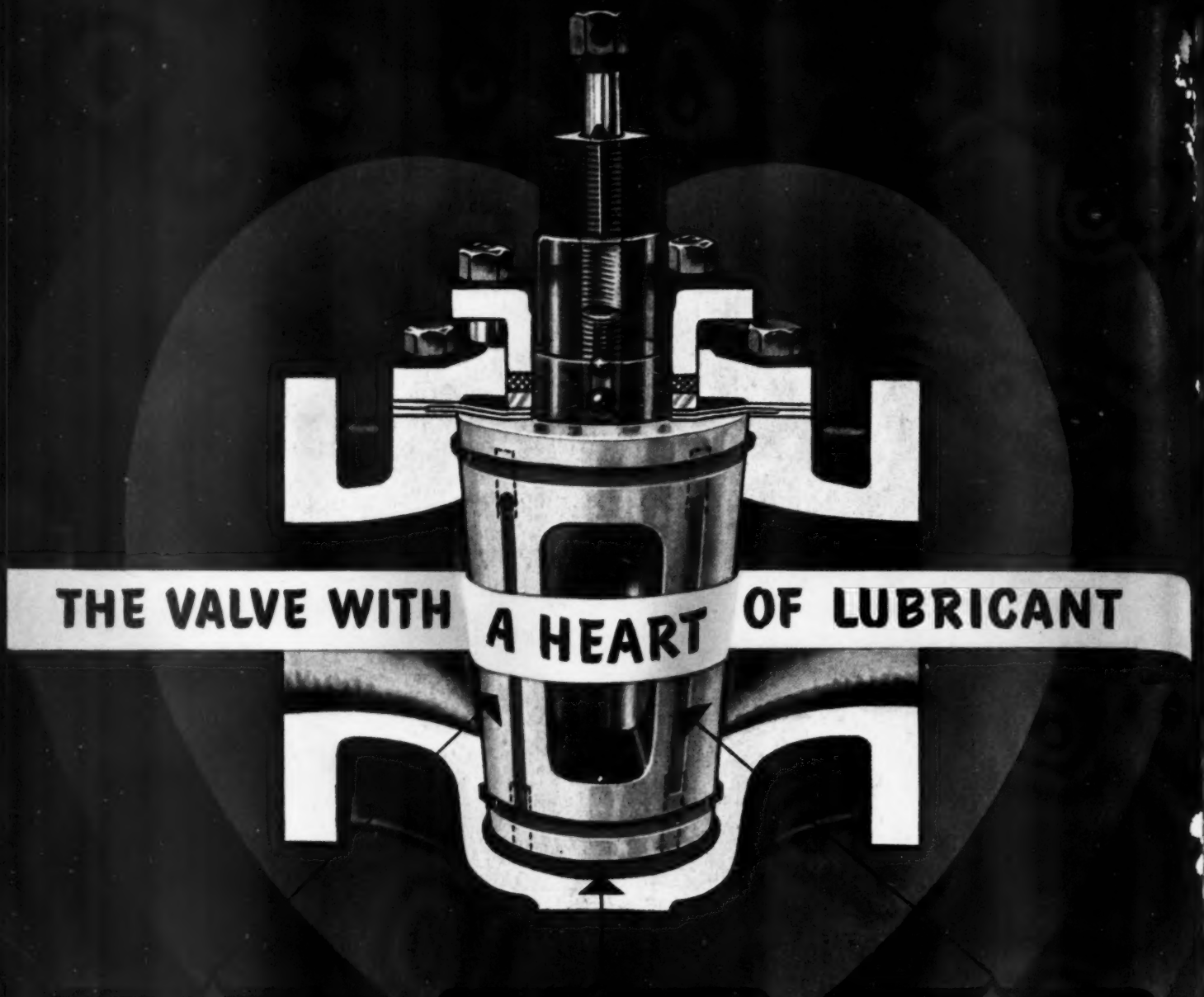
Sperry Ultrasonic Reflectogage for Non-destructive Measurements of Thickness, Bulletin 3700: describes theory and general application of the instrument to plate and sheet, tanks, boilers, pipe, etc. Sperry Products, Inc.

45—Hardfacing Technique

The Economies of Hardfacing; an 8-page reprint of an article from *The Welding Journal;* reviewing the advantages of hardfacing and offering an analysis of the problems leading to the correct selection of proper hardfacing rods. Air Reduction Sales Co.

More "What's New!" Items, p. 601


You can always count on
Nordstroms for quick,
tight shut-off
Nordstrom
LUBRICATED VALVES



THE VALVE WITH A HEART OF LUBRICANT

LUBRICATED SEAT
A film of lubricant is distributed between the tapered plug and its seat. This insures easy turning and protection against corrosion, erosion and intrusion of line material. Rotary plug prevents exposure of seats.

LUBRICANT JACKING CHAMBER
By turning the external lubricant screw, lubricant under pressure produces a jacking action on the plug. The thrust of the plug against the top shoulder stem seal gives resiliency.

POSITIVE SEAL AROUND PORTS
Grooves in plug, connecting with grooves in body, form an unbroken circuit around each port. Lubricant in the grooves prevents leakage past any part of the port boundry.

Something to think about before you buy valves

One "temperamental" valve on an important line in your plant or in the field might tie up your major flow of production. Check back in your experience and you can recall such instances. A single valve failure usually costs many times the price of the valve. Nordstrom valves are the "traffic controls" in well-engineered installations. They are literally the *heart* of the flow lines; easiest to switch flow; quickest to turn on or off; free from sticking; protected against leaks by "Sealdport" lubrication. The tapered plug is always seated. No sediment or deposits can creep in to prevent a tight closure. Nordstroms give line control not obtainable with any other type of valve. They are most economical in service. Buy them. Try them. ***Performance is the proof.***

Keep Upkeep Down
Use *genuine*
Nordcoseal lubricants

Nordstrom
LUBRICATED ROCKWELL VALVES

Sealdport Lubrication

NORDSTROM VALVE DIVISION—***Rockwell Manufacturing Co.***—400 No. Lexington Ave., Pittsburgh 8, Pa.

Atlanta • Boston • Chicago • Houston • Kansas City • Los Angeles • New York • Pittsburgh • San Francisco • Seattle • Tulsa • and leading Supply Houses

Export: Rockwell International Corporation, 7701 Empire State Bldg., New York 1, N.Y.

What's New!

46—Story of Oakite

Oakite News Service, 40th Anniversary Issue: tells the history of the company and how its combination service-and-product scheme was developed; includes pictorial story of training program for technical representatives. Oakite Products, Inc.

47—Flexible Metal Hose

Flexible Metal Hose, Bellows, Expansion Joints, Catalog G-50: a 68-page book presenting complete information on a line of flexible metal hose, expansion joints, stainless steel and brass bellows, and various conduits and special assemblies. Chicago Metal Hose Corp.

48—Fabricating Handbook

Handbook for the Fabricator, 1949; 128-page booklet describes various types of "Eastern" chromium-nickel steels, their application, and includes engineering data on corrosion resistance values, physical and chemical properties, etc. Eastern Stainless Steel Corp.

49—Portable Refractometer

Bausch & Lomb "Abbe-56" Refractometer; Bulletin D-241: a four-page catalog section, including price list as of March 1, 1949, on a new portable refractometer with an index range of 1.30 to 1.71 and a reading accuracy of two units in the fourth decimal place; and featuring spare interchangeable prism sets that can be installed by the user, eliminating lost time during prism reconditioning. Bausch & Lomb Optical Co.

50—Improvement by Forging

The Improvement of Metals by Forging; a 44-page booklet describing the basic types of forgings, their characteristics and applications; including chemical composition, relative machinability, and processes employed in their manufacture. The Steel Improvement & Forge Co.

For Your Convenience

Business reply cards are included in this issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing page 585. Just circle the numbers corresponding to the numbers on the items you're interested in, fill in the bottom of the card, and drop it in the mail. No postage required.

B.T.U. digest

THROWING LIGHT ON HEAT TRANSFER PROBLEMS

THE WHITLOCK MANUFACTURING COMPANY
149 BROADWAY, NEW YORK 6, NEW YORK
Main office and Plant, 79 South St., Elmwood, Hartford 2, Conn.

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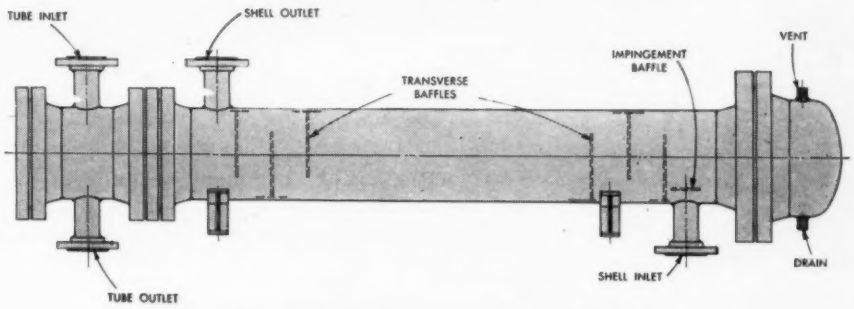


WHITLOCK
STANDARDIZES FOR ECONOMY

As an example of Whitlock Standardization the construction of the ST Heat Exchanger will be of interest. A good bit of our engineering effort has been devoted to standardization for the purpose of avoiding costly "specials" wherever possible. One of the results of this program is illustrated by the wide range of Standard Type ST Heat Exchangers now available. The Whitlock Type ST is a straight-tube floating head (split ring design) exchanger. Units are available in 150# and 300# design pressures and can be furnished of all-steel construction or with steel shell and nonferrous tube bundle construction, replacing many special, more costly units.

Today the reduction of manufacturing costs is of vital concern to all manufacturers, and standardization—whether partial or full—is a big step in the direction of economy. Standardization helps reduce engineering costs, and also permits quantity purchasing—resulting in reduced material costs. Partial or whole prefabrication of major subassemblies, even with heavyweight heat exchangers, likewise means lower production costs.

Standardization of the Whitlock ST Heat Exchanger now allows the application of low cost standard units to special and individual operating conditions, and greatly expedites deliveries. This is very important to the customer since single units, series of units, and replacement parts as well, are available for early shipment.

APPLICATIONS

The Whitlock Type ST Heat Exchanger of straight tube floating head design (split-ring assembly) has large scale application to the typical refinery heat transfer problem. Whether the service calls for heating, cooling or condensing and whether the process fluids have viscosity characteristics of a light fraction or of a heavy tar, the unit has application because of its fundamental consideration of thermal design details, mechanical characteristics and maintenance requirements.

WHITLOCK

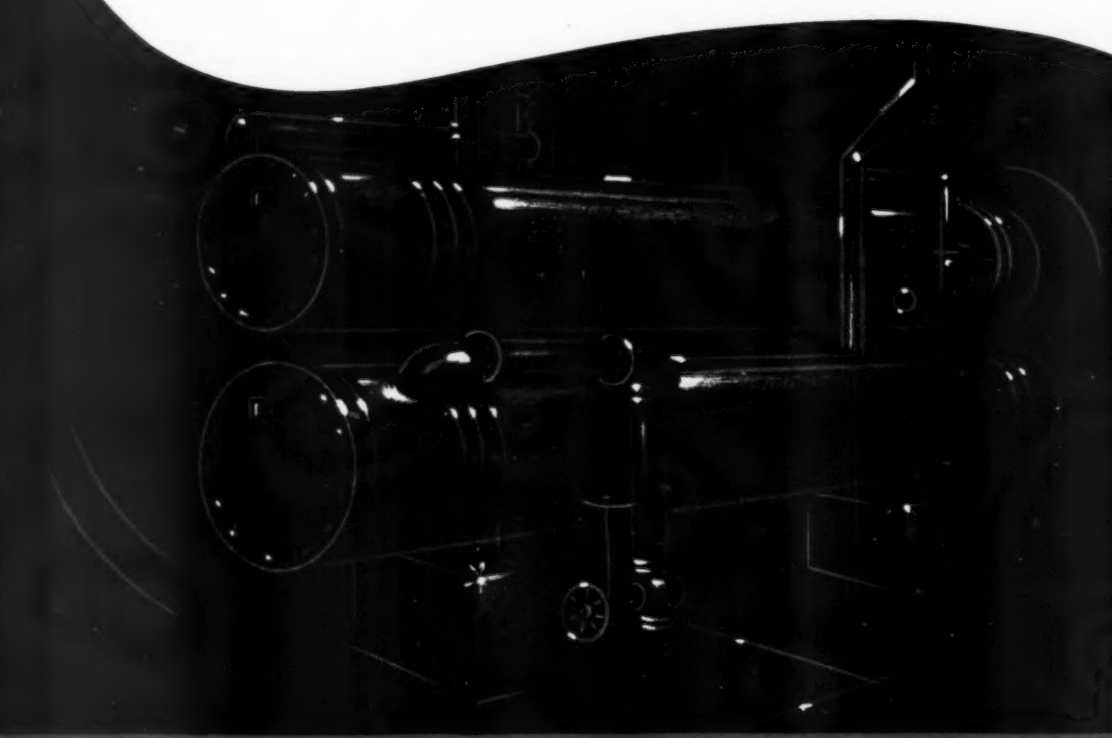
DESIGNS and BUILDS Bends · Coils · Condensers · Coolers · Heat Exchangers
Heaters · Piping · Pressure Vessels · Receivers · Reboilers

aluminum protects...

PROTECTS REFINERY HEAT EXCHANGERS

You can triple the life of your heat exchangers handling products of sour crude. Tube bundles of Alcoa Aluminum have lasted 18 years and more. Alcoa heat exchanger tubing, covered by A. S. T. M. specification B234-48T, resists corrosion by H_2S, CO_2 and products of sour crude. Alcoa Alclad tubing resists most cooling waters.

We've just published a booklet, "Alcoa Aluminum Heat Exchanger Tubes", that shows where aluminum tubing will improve your petroleum processing. You'll learn the ease of roll-in and fabrication with standard tools and procedure, as well as performance data. We will gladly give you copies if you'll call your nearest Alcoa Sales Office or write ALUMINUM COMPANY OF AMERICA, 1784 Gulf Building, Pittsburgh 19, Pennsylvania.



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Serving the Petroleum Processing Industry

General News

Republic Flow Meters Co., Chicago, began the first of a series of four-week courses May 2 covering the theory and practical side of flow measurement and automatic control. Instructors are specialists drawn from Republic's engineering staff. Company also is planning two separate one-week courses designed primarily for instrument mechanics. The first of these courses will cover the assembly, calibration, and adjustment of instruments: the second will deal exclusively with regulators. All short courses are open to experienced engineers, supervisors, and mechanics employed by Republic customers. For further information, address inquiries to Mr. J. B. McMahon, Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.

Corrosion achievement awards — Presentation of the 1949 Willis Rodney Whitney Award to Dr. R. B. Mears, manager of the research laboratory of Carnegie-Illinois Steel Corp., Pittsburgh, and 1949 Frank Newman Speller Award to Frank L. LaQue, in charge of corrosion engineering section, International Nickel Co., Inc., New York, was made April 13 during the annual meeting of the National Assn. of Corrosion Engineers in Cincinnati. Dr. Mears is the incoming and Mr. La Que, immediate past president of the NACE.

Tube rolling record reported—What is said to be a record for the number of tubes rolled by any one expander continuously in operation was established recently in a large eastern oil refinery with the aid of an Airetool type G-800 tube expander. Altogether, the report states over 18,000 tube ends, each ¾-in. O.D. by 14-ga., were rolled into a 1½-in. tube sheet during the operation. Both steel and brass tubes were rolled in equal numbers; however, it was not necessary at any time to replace rolls or the mandrel. Tubes were rolled at 750 rpm., which is faster than the rate recommended by the manufacturer, Airetool Mfg. Co., Springfield, Ohio.

Meetings on new alloy — International Nickel Co. has been conducting a series of meetings in centrally located cities in the U. S. and Canada on its corrosion and heat resistant alloy, "Ni-Resist." Meetings have been held in Chicago, Montreal, Springfield, Mass., Philadelphia, and Cleveland. Future discussions are planned for Birmingham, Ala., May 19; San Francisco, Sept. 16; and Los Angeles, Sept. 23.

Huge cracking unit assembly moved —The largest assembled piece of equipment, a section of a fluid catalytic cracking unit, ever moved from a plant in the Chicago manufacturing area was shipped recently by Graver Tank & Mfg. Co. from its East Chicago, Ind., plant for installation at Wood River Oil & Refining Co., Wood River, Ill. The section shipped was the bottom cone of the regenerator, which measures 19 ft. 8 in. inside diameter and extended 20 ft. 7 in. above the rails. Transportation was on a special "well-bottom" flat car.

Personnel Changes

Pittsburgh Plate Glass Co., Columbia Chemical Div.—William Carpenter has been named a sales representative at St. Louis, Mo.

Warner Lewis Co.—Byron E. Snow, formerly vice president and general manager of Aeroquip Sales and Engineering, Inc., has joined the sales department, where he will be concerned with sales promotion work, participate in policy determination, and supervise sales representatives.

Foster Wheeler Corp.—Vice Admiral Earle W. Mills, USN (ret.), has been elected executive vice president and a director. David McCulloch, executive vice president since 1935 and a member of the company since 1906, has been named vice chairman of the board. Recently retired from the Navy, Admiral Mills was wartime Deputy Chief of the Bureau of Ships and Chief of that bureau since 1946.

Cooper Alloy Foundry Co.—James E. Ziegler has been appointed to the sales engineering force, and will be stationed in Cleveland to provide increased technical service in the Pittsburgh-Cleveland-Detroit areas.

Spencer Chemical Co.—Robert W. Schramm, formerly with Carbide & Carbon Chemical Corp. at Whiting, Ind., has been added to the market research staff as market analyst, with headquarters at 610 Dwight Bldg., Kansas City, Mo.

Bjorksten Research Laboratories—Dr. Eugene L. Woroch, previously with the Wisconsin Alumni Research Foundation, has joined the Bjorksten staff as a section leader. James E. Henning, of Kester Solder Co. has been added as a research chemist.

Hooker Electrochemical Co.—S. I. Anderson, in the sales department since 1933, has been promoted to assistant to the general sales manager. T. H. Trimble, with Hooker since 1934, is now eastern sales supervisor. Headquarters for both men will be at the Niagara Falls offices. Neil M. Barber, will be assigned to the area comprising eastern Pennsylvania and the southeastern seaboard states.

M. W. Kellogg Co.—John W. Copenhaver, formerly with General Aniline & Film Corp., has joined as head of a research group in the Jersey City petroleum and chemical research laboratories of Kellogg.

Ralph M. Parsons Co.—Brig. Gen'l. L. D. Worsham, USA (Ret.), has joined as resident manager at Los Alamos on the work being performed there for the Atomic Energy Commission. Clinton C. Steward joined as chief engineer with headquarters at the main office in Los Angeles. He replaces Elwood Layfield, who has been given the new position of manager of engineering and construction.

Ethyl Corp.—Dr. Charles L. Smith, for the past four years technical advisor of the National Agricultural Chemicals Ass'n., has been appointed to Ethyl's product development department in New York City.

Peabody Engrg. Corp.—Robert C. Vroom has been appointed Executive Advisor and Consultant, with headquarters at 580 Fifth Avenue, New York City. Holder of a number of basic patents related to the combustion of fuels, Mr. Vroom has been for many years chief engineer with Peabody.

Dow Chemical Co.—Several shifts in the top executive staff were made April 5 as result of the untimely death on March 31 of Dr. Willard H. Dow, president, in a plane crash near London, Ont., which also took the lives of Dr. Dow's wife and three other persons.

Earl W. Bennett, treasurer since 1930, was elected chairman of the board. Leland I. Doan was elected president. Mr. Doan had been a vice president since 1938 and secretary since 1941. Dr. Mark E. Putnam, a vice president since 1942, was named general manager. Dr. Dow had held all three of the positions thus filled, but in recent years had abandoned the title of board chairman and general manager. Two new vice presidents also were named: Dr. A. P. Beutel, general manager of the Texas Division; and Russell L. Curtis, general manager of the Great Western Division. Carl A. Gerstacker was elected treasurer and Calvin A. Campbell, the firm's legal counsel, was elected secretary.

Leece-Neville Co.—S. Floyd Stewart, executive vice president since 1946, was elected president recently, succeeding the late B. M. Leece, who died last December. Mr. Stewart joined the company in 1936 as a research engineer. Charles S. Cook, for eight years assistant to the president, was elected a vice president. J. S. Allt, in the accounting and purchasing departments for 12 years, was appointed auditor.

General American Transportation Corp.—Ben King Duffy, formerly with the Turbo-Mixer Division, has been appointed sales representative in the Pittsburgh district for the Plate and Welding and Process Equipment Division.

Brown Fintube Co.—E. A. Bertram has been appointed Manager of Sales, with headquarters at the general offices in Elyria, Ohio. Mr. Bertram will be in charge of all selling of the company's products in the petroleum and chemical industries through representatives in the principal cities of the U. S.

Mathieson Chemical Corp.—Dr. Carl F. Prutton, who joined the company in 1948 as director of research, has been named vice president-director of operations of all plants. He will be located in the New York offices. Arthur T. Bennett, vice president, was placed in charge of eight plants acquired from Southern Acid and Sulphur Co., and will have his headquarters in Houston. R. B. Worthy, manager of the Saltville plant; and J. F. Newell, manager at Lake Charles, were named vice presidents.

Patterson-Ballagh, Div. of Byron Jackson Co.—J. P. Magoffin has been promoted to general sales manager with the recent retirement of J. C. Ballagh.

Wolverine Tube Division of Calumet and Hecla Consolidated Copper Co.—T. P. Stone and M. J. Cook have joined the sales division and are assigned to the southeastern states.

Specialized Instruments Corp.—K. Kennard Gross, previously coordinating engineer with Leeds & Northrup, has joined the firm as eastern service manager for Spinco Ultracentrifuges, with headquarters in Philadelphia.

L. O. Koven & Brother, Inc.—W. C. Osha has been appointed plant superintendent of the Dover fabricating plant. Before coming to Koven, he was assistant general supervisor of welding for Pullman Standard Car Mfg. Co.

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Westinghouse Electric Corp.—John Z. Linsenmeyer has been appointed manager of mining, petroleum and chemical engineering, succeeding Phelan McShane who becomes consulting mining engineer for the company. Mr. Linsenmeyer, who joined Westinghouse in 1937 after graduation from Lehigh University with a B.S. in Electrical Engineering, is secretary of the Pittsburgh Section, American Society of Mechanical Engineers and has contributed articles to the industrial trade press on applications of electrical equipment in industry.

Kerr-McGee Oil Industries, Inc.—C. J. Colby has joined the firm as director of purchases and material with headquarters in the main office at Oklahoma City. For the past four years, he has been manager of machinery sales for Republic Supply Co.

James Webb Gosselin, 27, son of E. N. Gosselin, president of Graver Tank & Mfg. Co., Inc., was killed in an automobile accident in Chicago, March 27. He had been with Graver since February, 1947, and at the time of his death was production manager of the East Chicago plant.

A graduate of Northwestern University, Mr. Gosselin served as a Naval officer in the Pacific theatre of war at Saipan, Leyte, Luzon, Iwo Jima, and Okinawa during 1943-46.

Surface Combustion Corp., Standard Furnace Division — Berton M. Sharpe, with the company since 1937, has been appointed sales engineer to cover southern Indiana, southwestern Ohio, and northern Kentucky.

Pennsylvania Salt Mfg. Co. — George B. Beitzel, who joined the firm 19 years ago and since January 1 was executive vice president, has been elected president. Leonard T. Beale, president for the last 20 years, will continue as chairman of the board.

Swift & Co.—F. E. Lacey, with the company since 1926 and head of the industrial oil department since 1944, has been made manager of the Technical Products Plant at Hammond, Indiana, which processes fat and oil for use in the manufacture of lubricants, rubber, textiles, paint, and other products.

Dearborn Chemical Co., Ltd. — H. Neville Potter, technical director of this Canadian company since 1945 and a member of the Board of Directors since February, 1947, has been elected executive vice president and general manager. He will make his headquarters at the main offices in Toronto. A graduate in chemical engineering from the University of Toronto in 1937, Mr. Potter served three years with the Royal Canadian Air Force.

Electric Steel Foundry Co.—James T. Gow, for the past 13 years associated with the Battelle Memorial Institute in Columbus, Ohio, where he became Supervising Metallurgist in Industrial Metallurgical Research, has been named chief metallurgist for ESCO, with headquarters at main offices in Portland, Ore.

Black, Sivalls & Bryson, Inc.—Benjamin W. Bourne, sales engineer in charge of New Orleans office, has been transferred to Midland, Texas, office. Raymond D. Canada has moved from Kilgore, Texas, branch, to open a new office at Magnolia, Ark. James R. Banks, recently with Townsco Equipt. Co., Oklahoma City, has joined BS&B at New Orleans. C. W. Hayes, formerly at Kansas City, has taken temporary charge of New Orleans office. Floyd C. Myers,

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regional sales manager, has transferred headquarters from Lubbock to Midland, Texas, where his new residence address will be 2006 West Indiana. John T. Cross, Jr., previously at Odessa, Texas, has been promoted to branch manager at Hobbs, New Mexico.

Olin L. Medley has joined the sales engineering staff at Shreveport, La. Joe Beggs, manager for 12 years at McPherson, Kans., is now manager at Ellinwood, Kans. W. O. Shook moved from Hays to become manager at McPherson. M. F. Barnes, transferred from Ellinwood to regional office at Great Bend. Charles W. Stevens left the Odessa, Tex. branch, to open a new office in San Angelo, at 2320 West Ave. "J".

Mathieson Chemical Corp.—Roland F. Boehm, who was district sales manager of the Houston office, has been transferred to the ammonia department, with headquarters in New York City. O. J. Theobald, Jr., formerly district sales manager at Charlotte, N. C., replaces Mr. Boehm at Houston. J. F. Carey, sales representative in Charlotte territory, has been named to Mr. Theobald's post.

Sid Richardson Carbon Co.—Robert Jaeger has been named a member of the sales department, with headquarters at the division office, 335 So. Main St., Akron, Ohio. He was for 16 years a member of the technical and lubricating sales department of Standard Oil Co. (Indiana) before coming to Akron.

National Supply Co.—F. W. Bremmer, a 25-year employe and works manager of the Spang-Chalfant Division's Ambridge, Pa., plant since May, 1948, has been elected vice-president in charge of manufacturing, a position left vacant since the retirement of Charles R. Barton a year ago.

The Kellex Corp.—Dr. W. A. Bain, since 1947 assistant to the technical director, has been promoted to the post of director of chemical research. Kellex is a subsidiary of M. W. Kellog Corp., and engineers in the field of nuclear energy.

E. F. Drew & Co., Inc.—Two additions have been made to the technical and research departments of the Power Chemicals Division. Vincent P. Murphy, formerly of Hall Laboratories, has joined the technical department; and John H. Wood, formerly of Permutit Co., has joined the research department.

Askania Regulator Co.—Wilson W. Wheeler, previously head of the sales engineering department, has been named sales manager.

Rockwell Mfg. Co., Meter and Valve Divisions—C. S. Bygate has been named assistant vice president. Before joining Rockwell in 1943, Mr. Bygate was with Stone & Webster Engrg. Corp. He will make his headquarters at the home office in Pittsburgh.

Elgin Softener Corp., Elgin, Ill., and **Illinois Water Treatment Co.,** Rockford, Ill., have joined forces so as to consolidate manufacturing operations and provide an organization of sales engineers and technical field men with offices in 40 cities. Each company will retain its name identity, however.

Yarnall-Waring Co.—Joseph Kildare, sales manager, has been named vice president in charge of sales; and Frank W. Miller, works manager, has been named vice president in charge of manufacturing. Carl Liberg, formerly in the New York sales office, is now in the new district of-

Sargent Constant Temperature Bath

The 0.01° C. Sargent Constant Temperature Water Bath, which is employed in many laboratories throughout the world where a precise, reliable thermostat is required, is now being supplied with an improved relay unit and heating system. The central heating and circulating unit of the bath is now equipped with three cylindrical heating elements rated at 200, 300 and 400 watts respectively. The 200 watt heater is controlled by the No. 81835 mercurial thermoregulator through a thyratron tube and saturable core reactor in the relay unit. (The use of a saturable core reactor obviates the difficulties commonly encountered with mechanical relaying systems such as pitted contacts, broken moving parts and freezing.) By means of a control mounted on the panel of the relay the output of this heater can be varied from the full 200 watts to approximately 60 watts, thus permitting such adjustment of the heater output that positive overshooting of the regulatory temperature is minimized. With the improved relay system this bath can be adjusted to a precision of ±.005° C. when operating in the vicinity of 25° C.

In addition, the relay unit is equipped with a master switch, a switch for each heater and a pilot light to indicate that the circuit to the 200 watt heater is closed.

Maximum power consumption 1100 watts.

S-84805 WATER BATH — Constant Temperature, 0.01° C., Sargent. Complete with Pyrex jar, 16 inches in diameter and 10 inches in height; central heating and circulating unit; constant level device; cooling coil; No. 81835 thermoregulator and relay unit with cord and plug for connection to standard outlets. For operation from 115 volt 50/60 cycle circuits **$230.00**

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fice in Buffalo. C. V. Peterson has been appointed a sales representative in the Cleveland district.

Kerotest Mfg. Co.—Stanley S. Willis has been made Chicago district manager of the brass division, with headquarters at 568 West Randolph St. Connected with the company since 1931, Mr. Willis has been production planning manager over all operations for the past ten years.

Expansion, Transition

Leece-Neville Co. has sold its old plant at 5363 Hamilton Ave., Cleveland, and is planning expansion of a wartime-purchased building at 5109 Hamilton. A plot 68 x 312 ft., adjacent to the plant, has been acquired. Additional floor space will be provided immediately by erection of a temporary structure pending completion of plans for a permanent addition. Another building, at 5351 Hamilton, also will be retained and expanded for use by the design and technical departments and engineering laboratory.

Cochrane Corp., Philadelphia, has announced the acquisition for cash of substantially all of the capital stock of **Liquid Conditioning Corp.**, Linden, N. J. The latter company will operate as a wholly owned subsidiary of Cochrane; its products for water conditioning will continue on the market under the trade name "Liquon."

Purchase of the **Machinery Division** of the **Taylor Mfg. Co.**, Milwaukee, was announced recently by A. C. Flamme, formerly sales manager, and C. E. Chavez, consulting engineer. The new company will be known as the **Taylor Dynamometer and Machine Co.**, and will have offices at 5108 West Center St., Milwaukee 10. Herman A. Karweik continues as chief engineer.

MacMen, Inc., a new company organized in Los Angeles, will provide Western industry with trained specialists capable of installing major equipment for any type of plant. A. F. Menke, a partner in MacIsaac & Menke Co., general contractors; and treasurer of MacMen, Inc., stated the new firm is operating throughout the eleven western states.

Clarostat Mfg. Co., Inc., located in Brooklyn, N. Y., since the early 1920's has moved its entire plant to Dover, New Hampshire. The move completed late in March, consolidates previous operations in Brooklyn's Greenpoint section, general offices in the Borough Hall section, and warehouses in Brooklyn and Patchogue.

Dowell, Inc. has opened a new treating station in San Angelo, Texas. Harold D. Wehrley, associated with Dowell since 1937, has been named manager. J. R. Mowery is service engineer.

John D. Trilsch Co., designers and installers of cathodic protection systems for refineries and pipe lines, has moved its offices from the Petroleum Bldg. to the M & M Bldg. in Houston, where it will have larger quarters.

Branches, Distributors

Petro-Chem Development Co. has appointed Flagg, Brackett & Durgin, Inc., 405 Park Square Bld., Boston 16, Mass., as representatives throughout New England.

Hyster Co. has named Machinery & Supplies Co., Inc. of Kansas City, Mo., as distributor of Hyster lift trucks, straddle trucks, and mobile cranes. Under the direction of George W. Gagel, president and general sales manager, the firm will operate in 60 counties in western Missouri, 31 in northern Oklahoma, and all of Kansas.

Aro Equipment Corp. of Bryan, Ohio, has named Aro Sales & Service, Inc., a newly-formed California corporation, as its sole distributor in California, Washington, and Oregon. Offices are at 2023 South Grand Ave., Los Angeles 7. A branch office in San Francisco is at 766 Brannan St.

Ernest E. Graham of E. E. Graham & Co., Houston, has been appointed sales representative for Cooper Alloy Foundry Co., with service covering Texas, Oklahoma, and Louisiana. In addition to Cooper, Mr. Graham is presently representing Erie Forge, Boston Woven Hose & Rubber, and Strom Steel Ball.

Brooks Rotameter Co. has announced the appointment of John G. Kirkpatrick as exclusive representative in the Pittsburgh area, including western Pennsylvania and West Virginia. He has been instrument engineer for Koppers Co. for the past seven years.

New Reprint Editions

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These two valuable series of articles which originally appeared in *Petroleum Processing* and its predecessor, the *Technical Section* of *National Petroleum News*, are again available. Out of print for some time, they have now been republished as a result of continued inquiries from readers.

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Gasoline and Cycling Plant Operation

Conducted by DAVE THORNTON

Data in answer to questions presented on these pages is supplied through the cooperation of authorities with the equipment and engineering companies of the Natural Gasoline Supply Mens Assn., among others. Readers are invited to submit queries on plant operating problems in their own work.

What causes the wood in a cooling tower to lose its strength — so-called delignification—and how may this be prevented?

Wood is highly resistant to most chemical attack because the fibers are cemented together with "lignin," which can be dissolved only by strong, very hot caustic solution. However, lignin is susceptible to attack by certain bacteria (*not algae*), producing materials soluble in moderately strong alkalis. After the lignin or the bacterial by-products are removed, wood loses its strength—is delignified.

This bacterial attack in alkaline water, such as occurs in many cooling towers, often is mistaken for a chemical attack. Rarely is either the temperature or alkali concentration sufficiently high in cooling towers to permit chemical deterioration.

In any cooling tower where total alkalinity of the water (sodium carbonate plus sodium bicarbonate) is high, conditions will favor growth of lignin-destroying bacteria. This is true whether the water is naturally high in sodium bicarbonate or a zeolite softener is used to convert calcium and magnesium bicarbonates to the corresponding sodium bicarbonate. Neither high concentration of sodium alkalinity nor the bacteria, alone, will destroy the wood; both must be present.

The high pH of a lime-soda softened water quickly drops when carbon dioxide is absorbed by aeration in the water. Total alkalinity, however, remains unchanged. It should be remembered that there is no mathematical correlation, as such, between pH and total alkalinity of an aqueous solution.

Theoretically there are two avenues to prevention—by "sterilizing" the water or by reducing the total sodium alkalinity.

The former is difficult to practice in cooling towers, although non-volatile bactericides are better than chlorine in this respect. Unfortunately, the non-volatile agents prove relatively ineffective in cooling towers against lignin-destroying bacteria, because many areas are alternately wet and dry or the agent may be dissipated by absorption into the wood. While too dry for the bactericide to be effective, the "dry" areas may be sufficiently moist for the bacteria to work.

The most efficient remedy is to avoid sodium alkalinity. Magnesium and calcium alkalinity is never high enough to dissolve the degradation products resulting from lignin-destroying bacteria.

In the case of a "hard" water, high in calcium and magnesium alkalinity, the recommended method is to treat with lime to drop carbonates out completely. For a natural bicarbonate water, it should be neutralized with sulfuric acid and deaerated to remove carbon dioxide. These bicarbonates also may be removed with a hydrogen exchanger (a zeolite-type softener regenerated with sulfuric acid instead of brine), followed by forced-draft de-aeration to remove carbon dioxide.—L. K. Cecil, Infilco, Inc., Tulsa.

May the compressibility factor method be used to estimate the densities of natural gas containing nitrogen in concentrations as high as 10%?

The compressibility factor method[3] may be used to estimate the density of nitrogen-containing natural gas if either the analysis of the gas or its gas gravity is known. It will be recalled that the compressibility, z, is applied as a multiplying factor to the ideal gas law in the form, $PV = z\,RT$, when P, V and T are the pressure, specific volume and temperature, respectively, and R is the gas law constant in consistent units. The factor, z, is a function of both the pseudo-reduced temperature and the pseudo-reduced pressure, where the pseudo-reduced temperature (or pressure) is the ratio of the actual temperature (or pressure) to the pseudo-critical temperature (or pressure). The pseudo-criticals to be used in the computation may be estimated by means of the gas gravity[2] or may be calculated as the volumetric average critical pressure or temperature if the gas analysis is known.

The latter method is preferable, but the use of the empirical relation between the pseudo-criticals and the gas gravity may be equally satisfactory.

To illustrate, the densities of the natural gas given in Table 1 have been computed by the compressibility factor method. The experimental densities[1] at 140° F. are compared in Table 2 with the calculated values. The densities given in Column 2 were computed using the pseudo-criticals calculated from the analysis, while those in Column 3 are based upon the pseudo-criticals obtained from the empirical relation with the gas gravity only.—D. L. Katz and Brymer Williams, Dept. of Chemical & Metallurgical Engineering, University of Michigan, Ann Arbor.

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(1) Eilerts, R. and Smith, R. V., U. S. Bureau of Mines Report of Investigations 3642, April, 1942.
(2) Mathews, T. A., Roland, C. H., and Katz, D. L., *Refiner & Nat. Gasoline Mnfr.*, June, 1942.
(3) Standing, M., and Katz, D. L., *Pet. Tech.*, July, 1941.

TABLE 1—Gas Analysis

Compound	Volume, %
Nitrogen	7.50
Methane	60.07
Ethane	14.77
Propane	13.42
i-Butane	1.44
n-Butane	2.37
Pentanes	0.43
Pseudo-critical temperature, ° R	426.6
Pseudo-critical pressure, psia	652.1
Gas gravity	0.8482

TABLE 2—Experimental and Calculated Densities at 140° F.
Density lb/CF

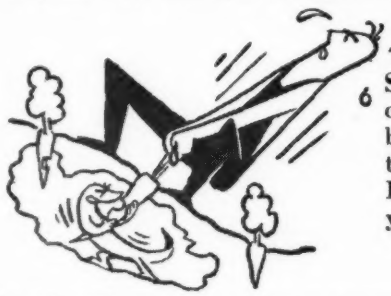
Pressure psia	Experimental	By analysis	Pseudo-critical from gas gravity
500	2.10	2.10	2.11
1000	4.68	4.68	4.75
2000	10.76	10.71	11.07
3000	15.35	15.33	15.72
4000	18.20	18.07	18.47
5000	20.07	19.84	20.20

Fascinating facts about your business

(Here are a few interesting things about oil and oil people to help you "talk up" the oil business to friends and customers. The better people understand your industry the better they'll think of you.)

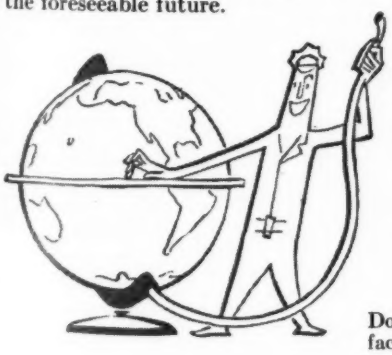
If the circus trapeze artists look happier these days, oil people can take a bow. Rope burn, long an occupational ailment of aerial performers, is now largely a thing of the past—thanks to a tubular sleeve of wicking that protects the performers from the burning, abrasive action of manilla ropes. Wicking is the material used in central draft lamps, oil stoves and portable oil heaters—one more of the thousand and one products produced by Petroleum.

Credit the oil industry with the first real advance in surveying methods since the Pyramids. For 5000 years, the shape of the earth's surface has been measured with rod and level—by men working their way on foot through snow and blistering heat. Comes now the answer to a surveyor's dream—an auto-drawn elevation measuring device which permits travel in comfort, helps cover up to sixty miles a day compared to eight miles averaged with traditional methods. Chalk up one more exhibit in the record of Petroleum's Progress.



Scientists predict that two million acres of land now lying idle in the Southwest can now be brought back into production—with the help of new soil fumigants developed by oil. Slated for rough treatment at an early date are the nematodes—which attack thousands of plant species, including tomatoes, cabbage, corn, tobacco and citrus. Here is another example of how oil research helps farmers produce more of your urgently needed food.

Oil exploration is now taking to the air with an amazing airborne magnetic device. So sensitive that it measures one part in 50,000 of the earth's magnetic intensity, this new device speeds up exploration a thousand fold. Immense stretches of ocean, impenetrable mountains and bleak arctic tundra, where great new reservoirs of oil may lie waiting, can now be expected to give up their secrets in the foreseeable future.



Next time somebody mutters a warning about the end of oil supplies being imminent, here are some facts you can offer: Since 1859, when oilmen first began to punch and drill holes into the earth, they have found some 128 billion barrels of crude oil, of which 58 billions have been produced. They're finding more all the time, faster than we're using it up right now. And scientists estimate that if present supplies should ever be depleted, oil shales and coal deposits would assure adequate supplies of liquid fuels for at least 1000 years.

Do you have any interesting facts about the oil business to pass along? We'll pay $10 for every item used in this series.

OIL BUILDS FOR AMERICA'S FUTURE

Oil Industry Information Committee
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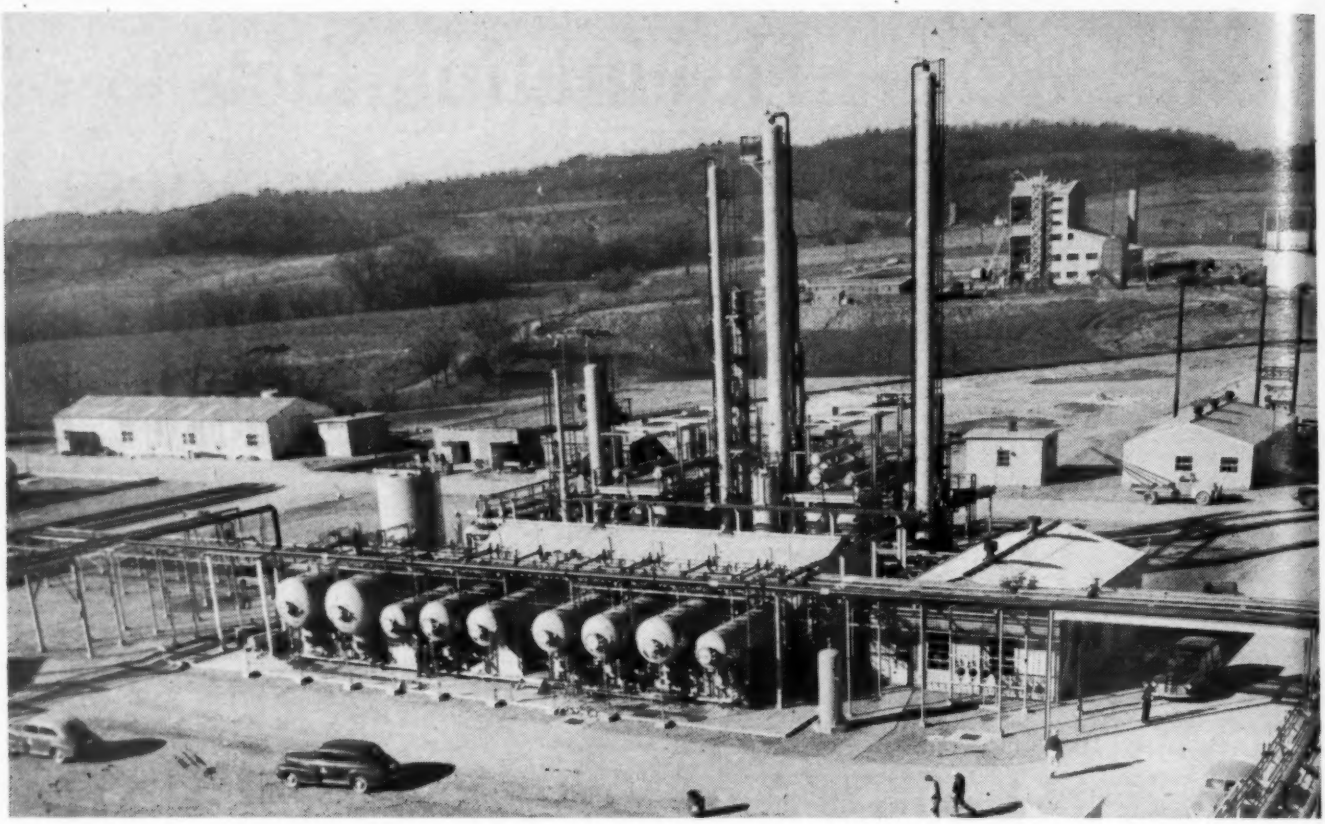

Photo courtesy U. S. Bureau of Mines

Distillation area of the hydrogenation plant at Louisiana, Mo.

Mines Bureau Dedicates Demonstration Plants For Study of Coal-to-Liquid-Fuels Processes

TWO demonstration plants for study by the Bureau of Mines of the manufacture of synthetic liquid fuels from coal were dedicated at ceremonies on V-E Day Anniversary, May 8, at the plants, site at Louisiana, Mo., about 100 miles above St. Louis on the Mississippi River.

Said to be the first of their kind built in this country, the plants are being erected at a combined cost of $15 million, and will serve as proving grounds for the respective merits of two basic methods for converting coal to oil:

1) Direct hydrogenation—the Bergius-I. G. Farben process.

2) Gas synthesis—the Fischer-Tropsch process.

The hydrogenation plant, with a production capacity of 200 to 300 b/d depending on the coal and catalyst used, now is ready for operation. Built under contract with the Bechtel Corp. of California at a cost of $10 million, the plant was designed for pressures up to 10,300 psi. in two major operations: 1) liquid-phase hydrogenation, which accomplishes the liquefaction of the coal, and 2) vapor-phase hydrogenation, which converts the liquefied coal to gasoline and byproducts.

Basically, the design of this plant follows that of the German units that were said to supply virtually all the aviation gasoline used by the Nazi air force during the war. Many improvements developed in American industrial research laboratories have been incorporated, however. Among them are the use of automatic instead of manual control to increase capacity and reduce personnel, new and cheaper sources of hydrogen, and a more efficient utilization of heat to lower product costs.

Initially, the plant will process western coals, which lend themselves well to hydrogenation. After operating difficulties are ironed out, typical coals from other sections of the country will be tested.

The process will produce, separately or simultaneously, liquid fuels ranging from high octane gasoline to Bunker "C" fuel oils with little or no changes in the plant. Byproducts will include phenols for plastics, "creosote" for wood preservation, solvents for paints, and hydrocarbon gases for heating fuel.

Now under construction, the second unit—the gas synthesis plant—is scheduled for completion this year. A contract for its design and construction was awarded to Koppers Co., Inc., of Pittsburgh, in March, 1948, and the cost is estimated at $5 million.

An 80 to 100 b/d unit, this plant will gasify pulverized coal with oxygen and superheated steam, and then convert the resulting synthesis gas—a mixture of carbon monoxide and hydrogen—to liquid fuels by the indirect Fischer-Tropsch synthesis. With American modifications, this process is reported to be well adapted to the production of either a good grade of motor gasoline or an excellent Diesel fuel. Product costs are expected to approximate those of the hydrogenation process, about 12 to 15c/gal. for gasoline from a 30,000 b/d plant with no credit for byproducts, according to Bureau engineers.

Personals

James H. Curtis is manager of refineries in the manufacturing department of General Petroleum Corp. A graduate of the University of Michigan, he was with Lummus Co. as process engineer and came to General Petroleum Corp. in 1942. He was assistant manager at Torrance in 1944 and was made manager there in 1945.

Mr. Curtis

Mr. Thompson

A. E. Thompson succeeds Mr. Curtis as manager of the Torrance refinery. He is a graduate of California Institute of Technology and joined General Petroleum in 1934 and was made assistant manager at Torrance in 1945.

Randal Maass becomes assistant manager at Torrance. He studied at California Institute of Technology and received his Master's degree from University of Southern California in 1936. He joined General Petroleum in 1934 and has served as chemist, gas engineer and refinery engineer.

* * *

John W. Copenhaver has joined M. W. Kellogg Co. as head of one of its research groups in the Jersey City, N. J., Petroleum and Chemical Research Laboratory. He was formerly with General Aniline and Film Corp. at Easton, Penn.

* * *

Victor VerMilyea is head of the Purchasing and Traffic departments of La Gloria Corp., Corpus Christi, Texas. A graduate of Virginia Military Institute, he was employed in the laboratories of United Refining Co., Warren, Pa., in 1933. He later became purchasing agent and assistant to the production manager. In 1945 he went to Ashland Oil & Refining as administrative assistant in the purchasing department.

* * *

Roy S. Godbey is manager of the Sales Engineering Division of Ashland Oil & Refining Co., Ashland, Ky. He was formerly with the Dynamometer Division of the Electric Products Co., Cleveland.

* * *

H. D. McClain is plant superintendent of the Opelousas, La., Gas Plant of Humble Oil & Refining Co., now under construction, being transferred from the Lovell Lake Pressure Maintenance Plant. **J. H. Kinsey**, former mechanical supervisor at Katy Gas Plant, has succeeded him at Lovell Lake.

* * *

J. H. Olehy is manager of Continental Oil Co.'s expanded general engineering department. Graduating in electrical engineering from the University of Colorado, he took special work at Massachusetts Institute of Technology, joining Continental in 1927. After several years in refinery maintenance and design engineering work he became chief process engineer and in 1948 was made director of technical services.

M. E. Clawson continues as chief construction engineer for Continental. Graduating from the University of Kansas he joined the company 30 years ago and was appointed chief engineer in 1935.

T. O. Duller is chief design engineer for Continental. He joined the company in 1925 and later became chief designer and then assistant chief engineer.

* * *

Dr. Theodore W. Evans is Director of Research for Shell Development Co., and will be in charge of the operation and research program of the Emeryville laboratories employing more than 1000 people.

Dr. Evans

He attended the College of Puget Sound, in Tacoma, and completed graduate work at the University of Washington. He joined the Emeryville staff in 1930 as a research chemist and was appointed an associate director of research in 1942 and was made manager in 1947.

Bruno Stolley will succeed Dr. Evans as manager of the Emeryville laboratories and will direct the administrative management of the lab-

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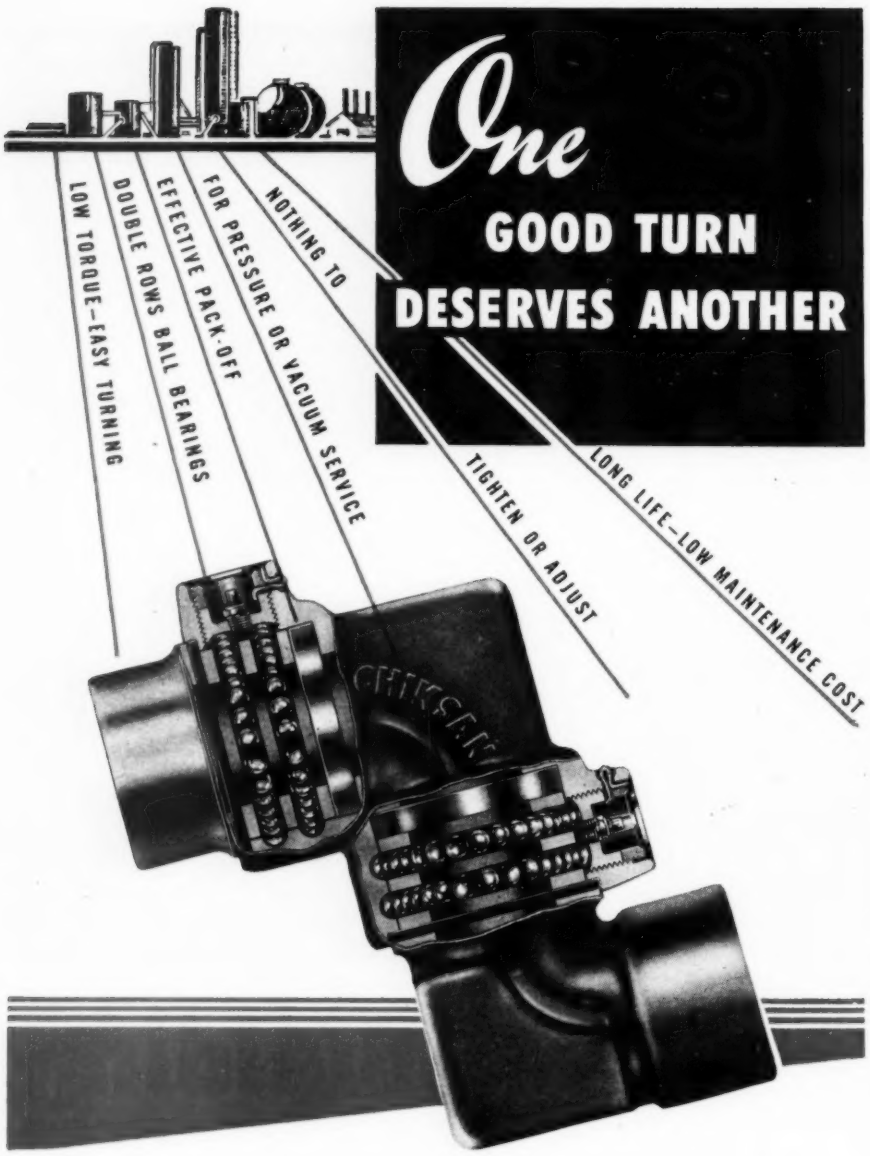

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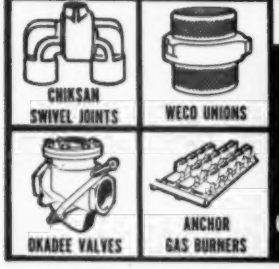

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Personals

oratories. He was former assistant manager of personnel for Shell Oil Co. in New York.

* * *

Mr. Drucker

Joseph J. Drucker is manager of the Estimating and Cost Control Department of the Catalytic Construction Co., Philadelphia. A graduate of Cooper Union Institute of Technology in mechanical engineering, he was with the Foster Wheeler Corp. for 20 years, 16 of which as chief estimator. During the past four years he has been with Arthur G. McKee Co.

* * *

Norman C. Penfold is assistant to Dr. Harold Vagtborg, director of the Southwest Research Institute, San Antonio, Texas. A graduate of Armour Institute of Technology, he was with Armour Research Foundation and later was supervisor of the engine test laboratory for Southwest Research.

Edwin R. Strong, Jr., is a technician in fuels technology for Southwest Research Institute. He received his master's degree from Illinois Institute of Technology and was formerly with the Institute of Gas Technology.

Dr. Judson Swearingen is chairman of engineering mechanics for Southwest Research Institute. He is designer and builder of petroleum cracking plants and has been engaged in atomic bomb research.

Duffer B. Crawford is gas research engineer for Southwest Research. A graduate of Texas Technical College, his specialty is the commercial production of gases.

Ion Edeleanu, New York, will be consultant on inventions and licensing for the Institute of Inventive Research, sister organization to the Southwest Research Institute. Receiving degrees from London scientific schools he has developed licensing programs for companies in this country and abroad.

* * *

Lyman R. Brown, 48, research associate in the Technical Service Dept., Socony-Vacuum Laboratories, Brooklyn, N. Y., died suddenly of a heart attack on March 22. He had been a member of the Socony-Vacuum organization for 21 years.

* * *

C. J. Tighe, engineer with Stanolind Oil and Gas Co., has been made plant superintendent of the company's new Stano gasoline plant at

Personals

Ulysses, Kans. Mr. Tighe has been field project engineer at the plant site in charge of construction.

* * *

Mr. Harold Moore has recently arrived in South Africa and is in charge of Harold Moore & Partners (Pty) Ltd., an affiliate of the Moore & Charlton associated companies. He is consultant and managing director of Union Petroleum Refinery (Pty) Ltd., who plan to build a refinery in South Africa.

Mr. Philip H. Moore is president of Moore, Charlton & Associates, Inc., with headquarters in Stamford, Conn., which will study American petroleum equipment and process development.

* * *

W. E. Hanford, Director of Petroleum and Chemical Research, has been elected a vice president of the M. W. Kellogg Co. Dr. Hanford, nationally prominent in many fields of research, joined the Kellogg organization in October, 1946, going to that company from General Aniline & Film Corp., where he was Director of Research. He was appointed to the newly created post of Director of Petroleum and Chemical Research at Kellogg in January, 1948.

Mr. Hanford

The election of Dr. Hanford took place at the annual meeting of the Kellogg board of directors, March 30. All other officers of the company, including M. W. Kellogg as board chairman and H. R. Austin as president, were re-elected.

* * *

Oronite Chemical Company has announced the appointment of **J. V. Powell** as General Manager, Development, a new position to cover activities in product development, technical service, market research and engineering.

Mr. Powell joined Oronite in 1947 as an engineer in the Product Development division. Previously, since 1941, he was with Standard Oil Co. of Calif., of which Oronite is a subsidiary.

* * *

George L. Parkhurst has been elected a vice president of Standard Oil Company of Calif. He is president of Oronite Chemical Co., California Standard's chemical products subsidiary.

Mr. Parkhurst joined Oronite in 1946 following service with the Petroleum Administration for War. Prior to the war, he was in the pe-

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troleum chemistry industry in the middle west. He graduated in chemical engineering from the Illinois Institute of Technology in 1927 and did graduate work in chemistry there for three years. He then studied law for four years and received his J. D. degree in 1934 at De Paul University.

* * *

C. C. Crawford is vice president and sales manager of Phillips Chemical Co., recently formed subsidiary of Phillips Petroleum Co., for the sale of carbon blacks and fertilizer materials. He was previously manager of the chemical products department of Phillips Petroleum.

* * *

The promotion of **Joseph J. Mikita** to be director of the Du Pont Company's Petroleum Laboratory was announced recently. The laboratory functions as a unit of the Technical Division of the Organic Chemicals Dept. and conducts research on the performance of fuels and oils in automotive engines.

Appointment of the heads of three laboratory divisions also was announced: **Richard O. Bender,** chemical; **Milton H. Campbell,** engineering; and **Robert H. Hobert,** service.

Mr. Mikita came to Du Pont in 1946 from The Texas Co., where he was associate director of research.

Before joining Du Pont in 1941, Mr. Bender had been a resident chemist at the Sinclair Refining Co.'s Marcus Hook, Penna., plant.

Mr. Campbell started with the Petroleum Chemicals Division in 1947 as a chemical engineer in the combustion engineering laboratory. For nine years previously, he had been engaged in engine research work for the Standard Oil Company (Ohio).

Mr. Hobert came with Du Pont following his graduation from Syracuse University in 1934.

* * *

J. T. Deane, vice president of Oronite Chemical Co., a California Standard subsidiary, is moving to San Francisco from New Orleans to take charge of all Oronite manufacturing operations.

* * *

T. I. Clausen is the new General Supt. in charge of manufacturing operations at the Oak Point (New Orleans) plant of Oronite Chemical Co., a subsidiary of Standard Oil Co. of Calif. Previously, Mr. Clausen had been acting assistant to the Manager, Chemicals Division, at California Research Corp., another California Standard subsidiary.

* * *

Charles W. Shaeffer, who retired in June, 1947, as manager of the Socony-Vacuum Oil Co. refinery at East Providence, R. I., has been named chairman of the board of managers of the East Providence branch of the Industrial Trust Co. Mr. Shaeffer started as an office boy in the Devoe Works of the former Standard Oil Co. of New York, and became manager of the East Providence refinery in 1931.

* * *

Bruce H. Clary has been appointed vice president and a director of Bareco Oil Co., Tulsa. Head of the refinery sales of the wax division since 1940 and an employe of Bareco since 1934, Mr. Clary is the author of a number of articles on manufacturing, properties, and uses of microcrystalline waxes. During World War II, he served for two years with the Petroleum Administration for War.

MEETINGS
. . . for the Oil Man

MAY

8-12, American Institute of Chemical Engineers, Regional Meeting, Mayo Hotel, Tulsa.
9-11, Liquefied Petroleum Gas Assn., Meeting and Trade Show, Palmer House, Chicago.
12-13, Instrument Society of America, 4th Annual Spring Meeting, Royal York Hotel, Toronto, Canada.
16-19, National Fire Protection Assn., Fairmont Hotel, San Francisco.
26-27, Natural Gas & Petroleum Assn. of Canada, Annual Meeting, Hotel London, London, Ontario, Canada.

JUNE

2, Manufacturing Chemists Assn., Skytop, Pa.
5-10, Society of Automotive Engineers, Summer Meeting, French Lick Springs Hotel, French Lick, Ind.
9, Chemical Market Res. Assn., Annual Business Meeting, Biltmore Hotel, New York.
20-24, American Institute of Electrical Engineers, Summer General Meeting, New Ocean House, Swampscott, Mass.
27-30, American Society of Mechanical Engineers, Semi-Annual Meeting, University of California, Extension Building, San Francisco.
27-July 1, American Society for Testing Materials, 52nd Annual Meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER

6-8, American Institute of Chemical Engineers, Regional Meeting, Mount Royal Hotel, Montreal (Que.), Canada.
12-16, American Society of Mechanical Engineers, Instruments and Regulators Division Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
12-16, Instrument Society of America, National Conference and Exhibit, Municipal Auditorium, St. Louis, Mo.
14-16, National Petroleum Assn., Hotel Traymore, Atlantic City, N. J.
18-23, American Chemical Society, 116th National Meeting, Atlantic City, N. J.
28-30, American Society of Mechanical Engineers, Fall Meeting, Lawrence Hotel, Erie, Pa.

OCTOBER

2-5, American Society of Mechanical Engineers, Petroleum Division Conference, Oklahoma Biltmore Hotel, Oklahoma City.
3-5, National Lubricating Grease Institute, Annual Meeting, Roosevelt Hotel, New Orleans, La.
10-14, American Society for Testing Materials, 1st National West Coast Meeting, Fairmont Hotel, San Francisco.
26-27, American Society of Mechanical Engineers, Fuels Division Conference, French Lick Springs Hotel, French Lick, Ind.

NOVEMBER

1-5, 2nd Pacific Chemical Expo, San Francisco Civic Auditorium, San Francisco.
7-10, American Petroleum Institute, Annual Meeting, Stevens Hotel, Chicago.
27-Dec. 2, American Society of Mechanical Engineers, Annual Meeting, Hotel Statler, New York.

DECEMBER

4-7, American Institute of Chemical Engineers, Annual Meeting, William Penn Hotel, Pittsburgh.

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EDITORIAL VIEWPOINTS...

Opinions and Comments on Current Topics

Automotive Industry Recognizes A Butane Utilization Program

THE SESSION ON VAPOR-LOCK of the API Refining Division meeting in Houston was significant in that a prominent representative of the automotive industry discussed in some detail the use of more volatile motor fuels, the increased volatility to be provided by the inclusion of larger volumes of butane.

The speaker was J. M. Crawford, vice-president of General Motors Corp. He made it clear that he was not appearing on the program as an official spokesman for the automobile companies. However, his position in the automotive industry is such that it can be assumed that his opinions are held by a great many in that industry who have to do with the design of cars.

This is the first time that so definite a statement has come from the motor car manufacturers on a matter which the petroleum industry has considered for some years with growing concern; namely, the efficient utilization of the light hydrocarbons from crude oil and natural gas, the volume of production and reserves of which are growing faster than those of petroleum. Mr. Crawford's talk contained two points of direct interest to the oil companies which supply the motor fuels the public uses in its cars.

First, while the automobile people do recognize a vapor lock problem, it is not a problem of itself but is only one of many that come up in the design of improved fuel induction systems. In designing a fuel system to use more volatile fuels many factors must be considered, said Mr. Crawford, even those connected with the production, storage and handling of the fuels prior to their introduction, through the carburetor, into the engine cylinder.

Any changes in the design of any feature of a car are justified only if they are in the public interest, he said. If fuel systems are to be such that higher vapor limit fuels can be used, the savings through the greater use of light ends must more than balance losses at other points, or any other offsetting features. It is not just a matter of providing a mechanical system that will operate on a fuel of higher vapor pressure.

As an example, Mr. Crawford said that the carburetor now installed on some of the present model cars of his company, because of a different location and a new air-cooling feature, can use a two-pound higher vapor pressure fuel without operating difficulties. However, said Mr. Crawford, this carburetor change alone could not be looked upon as solving the vapor lock problem and providing for the use of more volatile fuels.

The second point Mr. Crawford made in his talk was that any changes in the fuel induction system, as with other points in car design, must be made some years in advance of the introduction of the fuel. Cost to the automobile companies of re-tooling their plants is not justified until they know what fuels the oil companies are going to sell through their stations. He suggested the oil companies decide now what sort of fuels they will make about five years from now, so the automobile makers will have something to shoot at.

As to the first point made, that concrete benefits to the public must justify changes in design to eliminate vapor lock and thus provide for the use of more volatile fuels, a great deal of evidence on this point has already been prepared by the oil companies. It consists of data from road test work, surveys of reserves of natural gas and petroleum hydrocarbons, and so on. However, the oil companies should now arrange to secure and present whatever more is required, to establish beyond any doubt on the part of the automotive industry that conservation of our petroleum resources, with resulting long-range benefits to the public, will come about through providing for the greater use of butanes and eventually possibly other light hydrocarbons in motor fuels.

Congress Should Re-appraise The Synthetic Fuels Program

OUR RESIDUAL OILS, now burdensome to refiners, are a more economic source of light liquid fuels than coal or shale, Chester F. Smith, of Standard Oil Co. (New Jersey), vice-president of the API Refining Division, told its recent Houston meeting.

Fundamentally, there is every evidence that for many, many years Western Hemisphere crude oil production will continue to be adequate for Western Hemisphere requirements, said Mr. Smith. However, even if the demand for petroleum products should reach the level of crude oil availability, the refineries would be producing large quantities of residual fuel oil which could serve as a better raw material than coal or shale for an increase in the manufacture of light fuels.

"Such a solution to the problem would involve in many areas the direct substitution of gas or coal for some of the present uses of residual fuel oil, and the direct production of lighter fuels from that residual," he stated. "Synthetic production of liquid fuels, on the other hand, means the indirect, expensive and less efficient manufacture of oil from shale or coal. Synthetic plants require larger investments, more manpower and greater operating costs than the processing of residual."

There is a serious question, said Mr. Smith, whether there is any economic, conservation, or national security need for starting a large-scale program of construction of synthetic plants using coal or shale, either for immediate or near-future domestic requirements, or as a standby capacity for a potential emergency.

In the light of the increasing evidence that crude oil production alone will be sufficient to take care not only of our normal growth of consumption, but also our emergency needs, for an indefinite period into the future, Congress should reappraise all the proposals before it to build commercial synthetic fuel plants with government funds. Such programs would be a complete waste of public funds.

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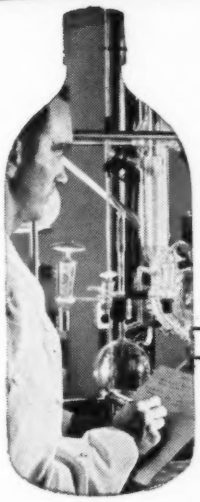

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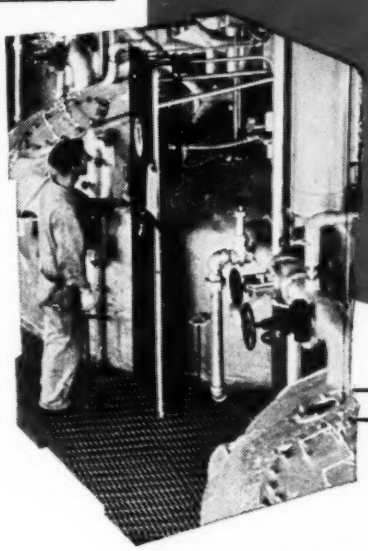

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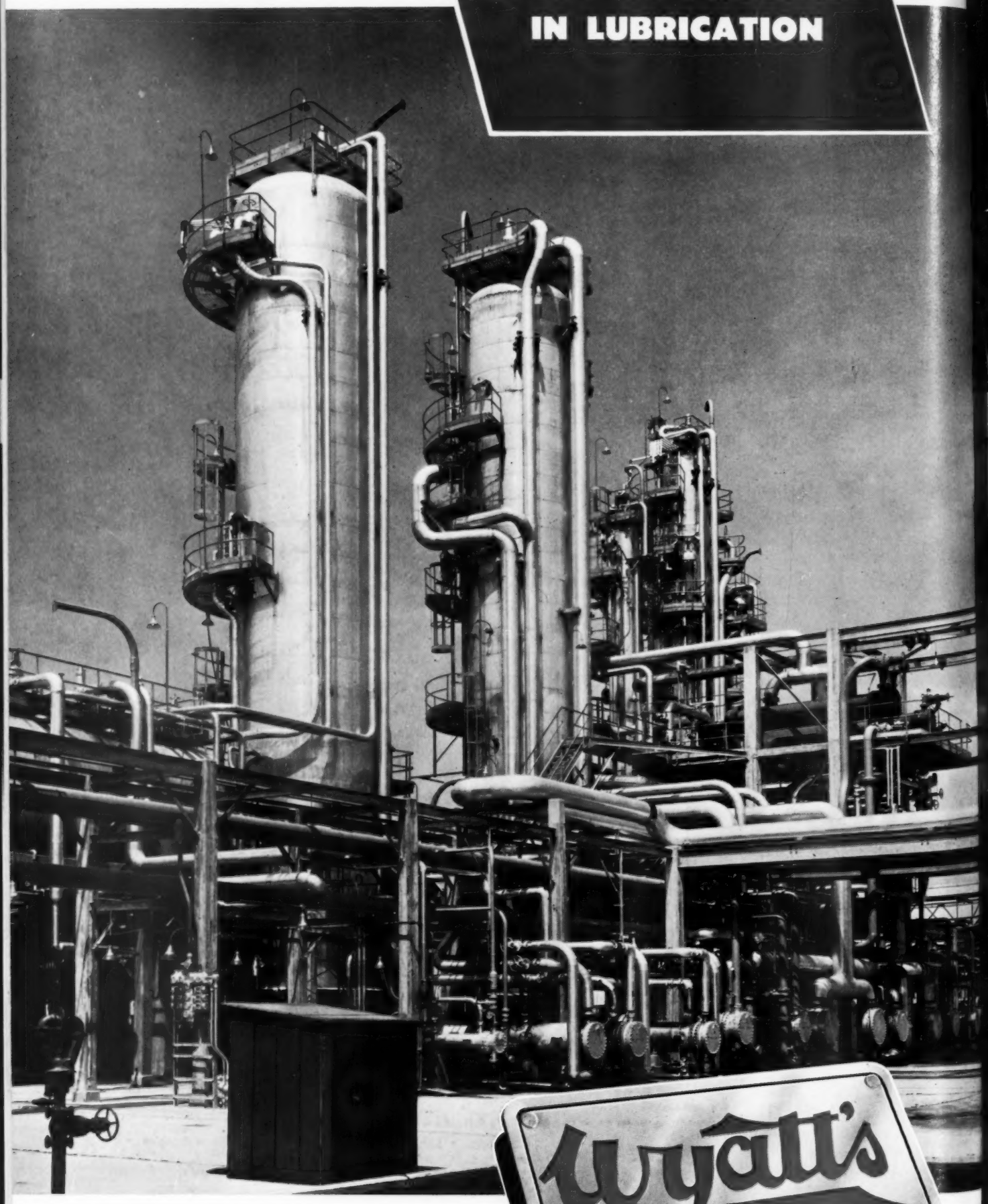

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